FAMOUS
RUSSIAN
AIRCRAFT

MIKOYAN
MiG-31

YEFIM GORDON

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Introduction

For years, the northern and eastern borders of the USSR were well guarded by Mother Nature herself; the vast expanses of water and ice made them inaccessible for any foes. Things changed dramatically in the late 1940s with the advent of strategic bombers possessing intercontinental range.

Since then, the Soviet leaders regarded the creation of a highly effective national air defence system capable of protecting the country from any attack as a top-priority task. With the onset of the Cold War the Soviet Union found itself at odds with nations possessing strategic bombers and cruise missiles capable of carrying one-megaton nuclear warheads which were capable of wiping out nearly all key industrial and military targets of the USSR within a very short time. Effective countermeasures had to be developed pronto.

The first Soviet surface-to-air missile (SAM) systems – the S-25 *Toon__goos__ka* and S-75 *__Vol__khov* (both named after Russian rivers and known to the Western world as the SA-2 *Guideline*) – had limited range and a kill altitude not exceeding 20 km (65,620 ft). Thus, they could only be used for point defence of major cities and military bases. SAMs were not enough to protect the vast country that the Soviet Union was. Conversely, missile-armed aircraft could destroy the attackers while these were still a long way from the Soviet borders. Manned interceptors were thus an effective solution for covering the huge expanses of Siberia and the Soviet Far East where building a lot of SAM sites was impossible. Thus the task of building a chain of air defence radars along the frontiers and fielding new interceptors capable of patrolling the borders for an extended time received the highest priority.

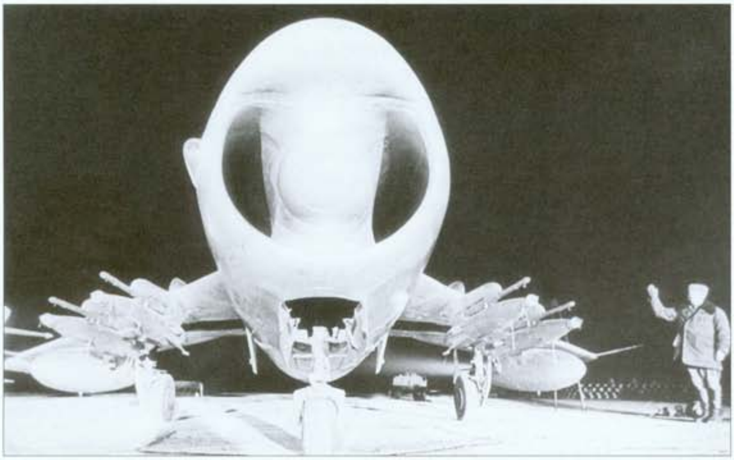
The first Soviet interceptors for the nation's Air Defence Force (PVO – *__Pro__tivovoz__doosh__naya obo__rona__*) were developed in the late 1940s and early 1950s. By the mid-1950s, however, cannon-armed subsonic interceptors could no longer cope with high-flying and fast targets. Two approaches were pursued: the first was to equip production tactical fighters with airborne intercept (AI) radars and air-to-air missiles (AAMs), while the other option was to design dedicated interceptors from scratch, tailoring them to the PVO's needs.

The adoption of the aerial intercept weapons system concept by the Soviet military in the mid-1950s was of prime importance for the Soviet Air Defence Force. The interceptor was now regarded as part of an integrated system comprising the aircraft as such (that is, a missile platform), AAMs, AI/fire control radars and ground-based guidance systems. The first Soviet aerial intercept weapons systems to enter squadron service were the ones based on the subsonic Mikoyan/Gurevich MiG-17PFU and the Yakovlev Yak-25K. Later, the supersonic MiG-19PM, Sukhoi Su-9, Su-11 and Yak-28P were fielded nationwide. Yet again these aircraft could effectively intercept an incoming target at a distance of several hundred kilometres from base, at best. A totally new type of aircraft was required for combating aerial attackers at distances in excess of 1,000 km (620 miles) and altitudes in excess of 20,000 m (65,600 ft).

The first attempt to create such an interceptor was undertaken by Semyon A. Lavochkin's OKB-301 in the second half of the 1950s. (OKB = *__op__ytno-kon__strook__torskoye by__uro__* – experimental design bureau; the number is a code allocated for security reasons.) The La-250 had a design endurance of more than two hours in subsonic mode and a top speed of 1,600 km/h (990 mph). Yet the test programme was plagued by accidents which, together with troublesome equipment and unsatisfactory handling, caused the trials to drag on for years and eventually led to the cancellation of the programme. Now the PVO high command found itself in a nice fix. Therefore, Artyom Ivanovich Mikoyan's OKB-155 was instructed to start work on superfast, ultra-high-flying heavy interceptors. (In this context, 'heavy' means that the aircraft is larger and heavier than the 'light' interceptors adapted from single-seat tactical fighters. Another reason for this term is that the 'heavy interceptors' are dedicated aircraft whose only mission is to destroy the enemy aircraft at long range; they are not designed for close-in combat.)

The Mikoyan OKB gained fame as a 'fighter maker' in 1949 when the famous MiG-15 was brought out; this was followed by the equally successful MiG-17, MiG-19 and MiG-21 tactical fighters. In the late 1950s the OKB tried its hand at 'heavy' designs. The first of them – the I-75, Ye-150 and particularly the Ye-152 series – suffered an ignominious fate. These aircraft, capable of destroying almost any target at altitudes of up to 22,000 m (72,180 ft) and ranges of up to 1,000 km (625 miles), did not progress beyond the prototype stage due to development problems and constantly changing requirements. The S-75 SAM's success on 1st May 1960 when Francis Gary Powers' Lockheed U-2 was shot down was undoubtedly a major contributing factor; the Soviet leader Nikita S. Khruschchov's bias towards rocketry killed off many a promising aircraft. (The Ye prefix means *yedinitsa* – 'unit', that is, 'one-off' aircraft, and was used to designate Mikoyan fighter prototypes right down to the MiG-25.)

Still, the threat posed by USAF's large strategic bomber force had to be countered, and the Mikoyan OKB persevered. The development work of the late 1950s and early 1960s was not in vain. The mighty Tumanskiy R15B-300 afterburning turbojet with a reheat thrust of 10,150 kgp (22,380 lbst) was verified on the Ye-152 series and finally entered production; major progress was also made in radar and air-to-air missile technology. Thus, many of the technological prerequisites for the birth of a high-speed long-range interceptor were there by 1960. What actually triggered its appearance was yet another round in the arms race.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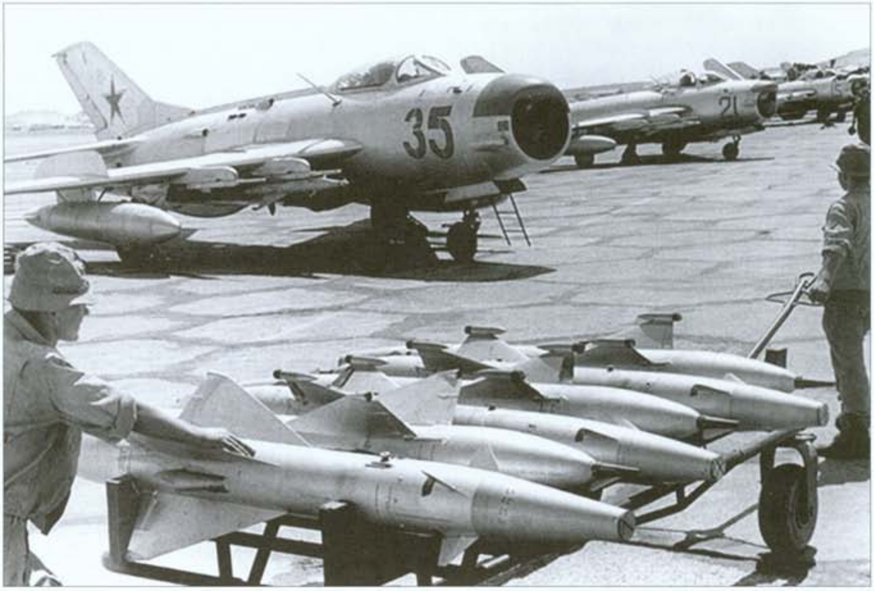
▲ **The Mikoyan/Gurevich MiG-17PFU, an upgraded version of the cannon-armed MiG-17PF, was one of the first Soviet all-weather interceptors to feature missile armament. This view shows the characteristic twin radomes of the RP-5 radar and the four RS-1-U missiles on underwing launch rails.**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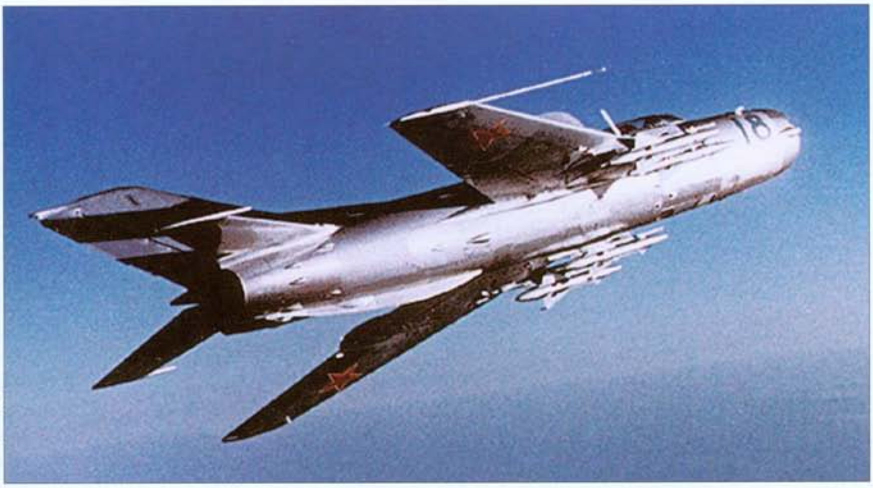
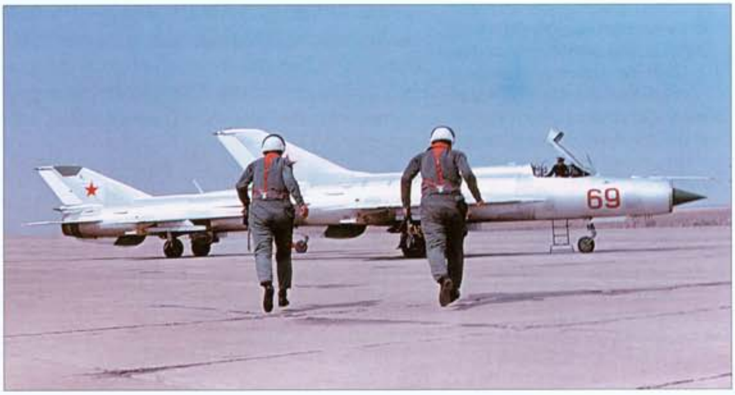
► **The subsonic MiG-17PFU was gradually supplanted by the supersonic MiG-19PM. Both types are shown together here, with a dolly loaded with RS-1-U (the ones with tracers at the wingtips) and RS-2-US AAMs in the foreground; the missiles are facing alternatively left and right and feature protective caps over the noses. Both aircraft had fairly modest capabilities, necessitating development of more modern interceptors.**



Vasiliy Kunyayev

◄ A magnificent view of a fully armed MiG-19PM as it banks away from the camera ship, showing off its sleek lines and sharply swept wings. Fighters operated by the Soviet Air Defence Force (PVO) normally had blue tactical codes as shown here.

Two PVO pilots sprint towards their MiG-21 interceptors. The aircraft in the foreground is a MiG-21PFS with a narrow-chord fin, while the other one is a later MiG-21PFS with a broad-chord fin. Both versions were operated exclusively by the PVO; nevertheless, the aircraft have red tactical codes. ▼



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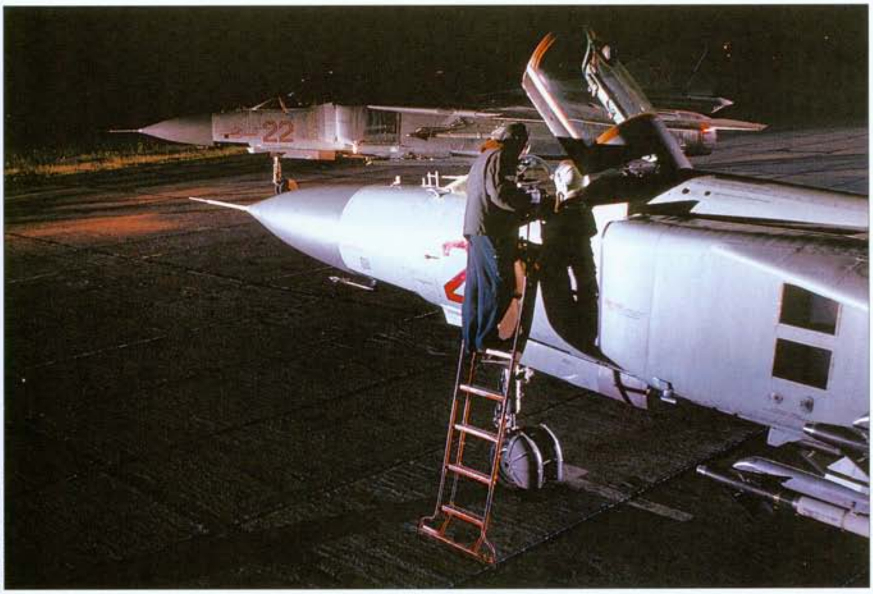
In February 1961 the Central Committee of the Soviet Communist Party and the Soviet Council of Ministers issued a joint directive tasking the Mikoyan OKB with developing an aircraft designated Ye-155; interceptor and reconnaissance versions designated Ye-155P (*pere**khvat**chik*) and Ye-155R (*raz**ved**chik*) respectively were envisaged. The actual development work started on 10th March 1961. Designed around a pair of R15B-300 engines, the Ye-155P had a powerful Smerch-A (Tornado-A) radar with a detection range of 100 km (62.5 miles) and was armed with a quartet of R-40 medium-range AAMs. The first prototype Ye-155P interceptor was completed



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◄ Two MiG-23Ms in air superiority grey camouflage armed with IR-homing R-13M missiles are prepared for a night sortie. The aircraft was operated both by the Air Force (VVS) and the Air Defence Force (PVO), but these two machines are PVO aircraft (red codes notwithstanding) because the R-13M AAM was on the PVO's inventory only. Note the 'Excellent aircraft' maintenance award badge on the far aircraft.

Yefim Gordon archive

▲
An atmospheric night shot of a Sukhoi Su-9 interceptor. The four RS-2-Us are not fitted here, but the two underfuselage drop tanks are. The Su-9 entered service in 1958 and remained in service for many years. Note the lengthwise positioning of the aircraft on the flight line, as was customary in the PVO in the 1960s.

in the summer of 1964, making its first flight on 9th September – soon after the Ye-155R prototypes featuring 'camera case' noses.

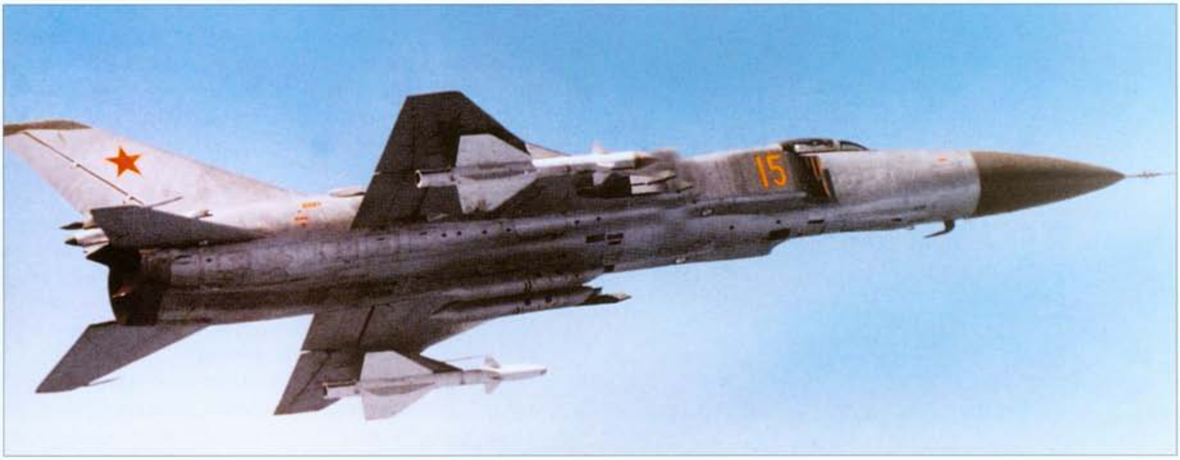
In 1971 the interceptor entered full-scale production as the MiG-25P and was codenamed *Foxbat* by NATO. Its Smerch-A1 (RP-25) radar could search and track targets either autonomously or using ground inputs relayed via the ***Voz****dookh-1* (Air-1) command link. After that, target lock-on, aircraft guidance towards the launch point and data feed to the missiles' warheads occurred automatically. The weapons load consisted of four R-40 missiles (two radar-homing R-40Rs and two IR-homing R-40Ts). The MiG-25P was fitted with the *La****zoor'*** (Prussian Blue) command link system connected with the radar and enabling the aircraft to be directed to the target area automatically or semi-automatically.

Officially the MiG-25P was cleared for service by a directive of the Council of Ministers dated 13th April 1972. By the mid-1970s it made up the backbone of the PVO's interceptor inventory. After converting to the MiG-25P, PVO units stationed near the borders successfully intercepted Lockheed SR-71A spyplanes approaching sensitive areas. The Blackbirds *could* have been shot down, despite the USAF's allegations to the contrary, and the only reason why they weren't is that no order to fire had been given. Anyway, the SR-71s and U-2s stayed clear of the areas where MiG-25Ps were based.

After Lt. Viktor I. Belenko's widely publicised defection to Japan in a MiG-25P on 6th September 1976 the Soviet air defence force found itself in a predicament again. The Americans had studied the MiG-25P in detail; unless the design was drastically upgraded, the type's combat efficiency would be far too low. To correct this, it was decided to develop a new weapons control system for new-build aircraft and retrofit it to existing ones. Hence the Mikoyan OKB developed a comprehensive upgrade in a remarkably short time. The Smerch-A radar was replaced by a new *Sap****feer-2****5* (Sapphire)/RP-25M radar. An infra-red search & track (IRST) unit coupled with the radar made the weapons system less

Sergey Skrynnikov

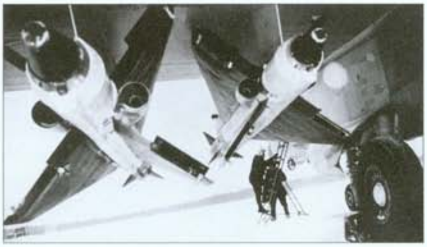
►
The Su-15TM was the ultimate production version of this aircraft and formed an important component of the PVO's fighter fleet until the late 1980s. This view illustrates well the cranked-delta wing planform of the 'TM.



Yefim Gordon archive

susceptible to enemy ECM and enabled the aircraft to make 'sneak attacks' without switching on the radar. An all-new ground-based command system and a new identification friend-or-foe (IFF) set were installed. The aircraft carried upgraded R-40TD/R-40RD missiles with almost twice the range.

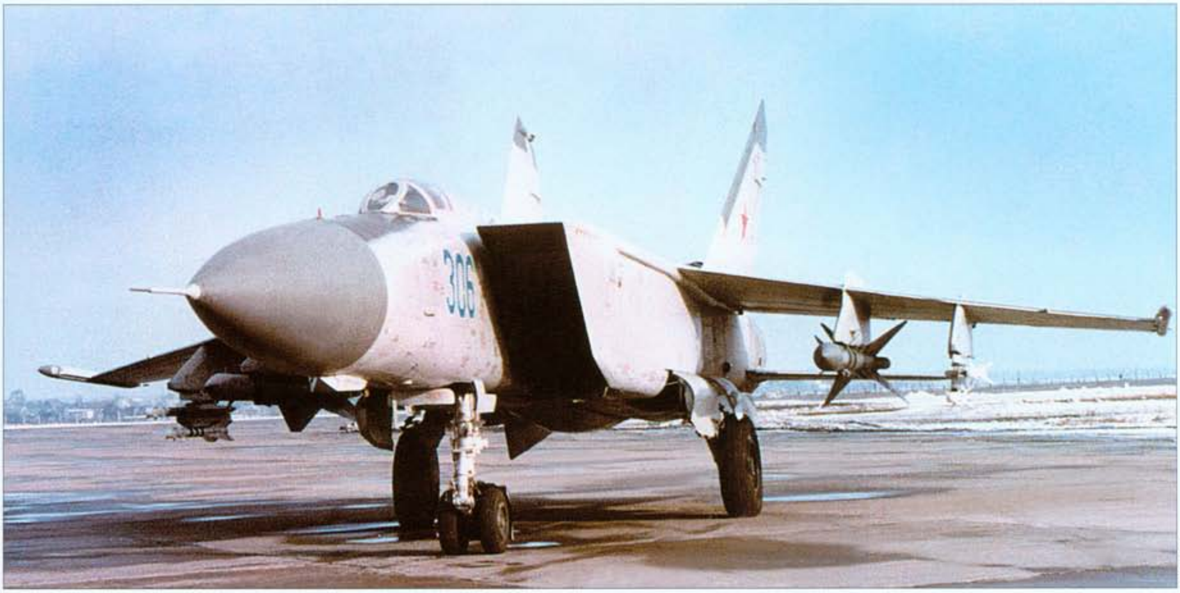
Work on the new interceptor, designated MiG-25PD (*dora***bot***annyy* – modified) progressed very fast. Several prototypes completed their test programme in 1978 and the type entered production in Gor'kiy that year. In 1979 the new version was officially added to the inventory and stayed in production until 1982; all early production aircraft were updated to MiG-25PD standard and redesignated MiG-25PDS (for *pere***khvat***chik, dora***bot***annyy v stro***yu** – field-modified interceptor). A small number of MiG-25Ps were exported to Iraq, Libya, Syria and Algeria; some of them are reported to have seen action in various local wars.



▲
Another Su-15TM carrying two R-8 AAMs (a heat-seeking R-8T to port and a radar-homing R-8R to starboard) and two UPK-23-250 cannon pods on the fuselage pylons. The yellow code is noteworthy.

◄
A pair of R-40TD AAMs under the port wing of a MiG-25PD.

This MiG-25PD, '306 Blue', carries a pair of R-40RDs inboard and four R-60s on APU-60-2 paired launch rails outboard.
▼



RSK MiG

Vyacheslav Martyniuk

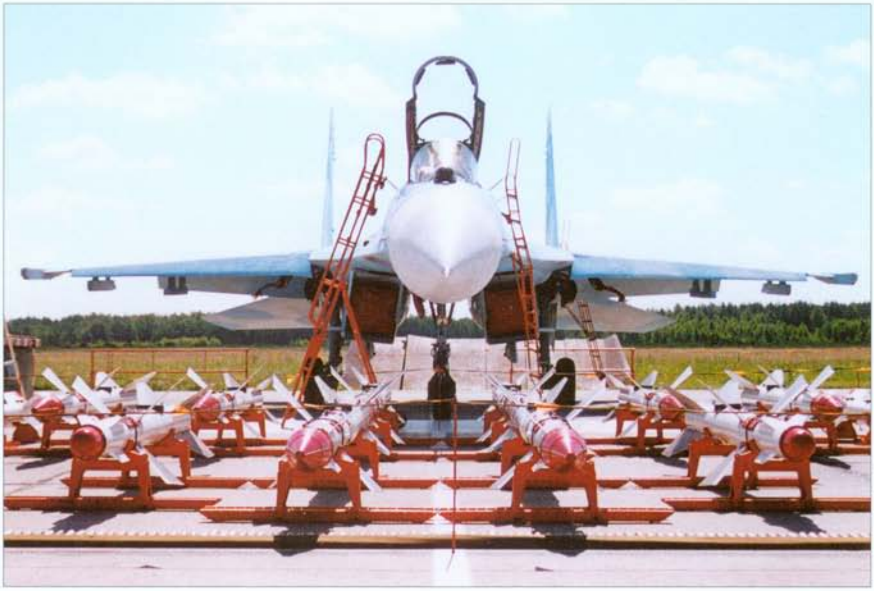
▲
'53 Blue', one of the Su-30 interceptors operated by the Russian Air Defence Force's Combat & Conversion Training Centre at Savasleyka AB. The aircraft carries four R-27RD missiles, two of which are suspended on the tandem centreline pylons.

In 1968 the Soviet government issued a directive ordering the Mikoyan OKB to design and build three versions (interceptor, strike and reconnaissance) of an aircraft designated Ye-155M. Initially the aircraft was merely an upgraded MiG-25; by the early 1970s, however, the objective was somewhat different. The USSR had long been suffering from inadequate air defence of the Polar Regions. Air bases with powerful avionics and navigational facilities were few and far between in the north. The existing air defence radars could only detect low-flying targets at close range. The MiG-25PD, Su-15TM and Tupolev Tu-128 interceptors equipping the PVO units stationed up north were hampered by limited range and outdated weapons systems. Therefore, the Mikoyan OKB proposed developing the MiG-25PD into a long-range interceptor capable of patrolling alone over the vast northern wilderness and defending industrial centres effectively.

The aircraft was to have long range and a cruising speed of about 3,000 km/h (1,864 mph) and to be capable of destroying multiple targets (including cruise missiles) in a single sortie. The crew was to include a pilot and a navigator/weapons systems officer (WSO). The idea was supported by the government and the PVO command.

Three basic versions of the new aircraft designated Ye-155MP were considered, differing only in wing design as the fuselage, the lateral air intakes and twin fins were borrowed from the MiG-25 in as-is condition. Version A had three-spar trapezoidal wings featuring small leading edge root extensions (LERXes); Version B featured variable-geometry wings; while Version C was a tailless delta with ogival wings of increased area.

Until 1st May 1960, when the U-2 met its match near Sverdlovsk, the Western world did not rate the Soviet air defence force. The Mikoyan OKB did a lot to change this, and a major contribution was made by the aircraft which is the subject of this book – the MiG-31 heavy interceptor; a type which, alongside the single-seat Su-27P and a handful of two-seat Su-30s, currently makes up the backbone of Russia's air defence force.



Vyacheslav Martyniuk

►
The Su-27P is one of the Russian Air Defence Force's principal types today. Here the aircraft is shown with the maximum possible ordnance load – ten R-27 medium-range AAMs (in both IR-homing R-27T and semi-active radar-homing R-27R versions), two R-73 short-range IR-homing AAMs and cannon ammunition.

PART ONE

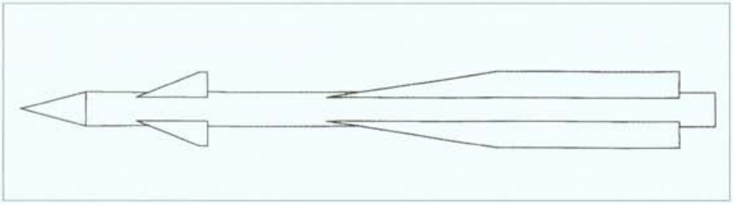
TAKING SHAPE

Foxbat Becomes *Foxhound*

The Preliminary Development Projects

The MiG-25 programme influenced not only foreign aircraft design practices, but most of all the Mikoyan OKB's own designs. The *Foxbat* served as a stepping stone towards a heavy interceptor unparalleled anywhere in the world. The Soviet leaders were interested in such an aircraft for the Soviet Air Force (VVS – *Vo**yen**no-voz**doosh**nyye **see**ly*), and with good reason.

As noted earlier, by the time the Ye-155MP programme was launched the USSR had long been suffering from inadequate air defence of the Polar Regions. Airbases with good navaids were few and far between in the High North. The existing network of air defence (AD) radars was capable of detecting low-flying targets only at close range, and the aircraft types equipping Air Defence Force units stationed up north were hampered by limited range and outdated weapons control systems.



Yefim Gordon archive

▲ A schematic drawing of the K-100 air-to-air missile which lost out to the K-33.

Hughes/World Air Power Journal

One of the Grumman YF-14A prototypes (note the red wings and long nose probe) carrying a full complement of AIM-54 Phoenix missiles. ▼

As early as 1965, when the Ye-155P prototypes of the future MiG-25P were in the midst of their test programme, OKB-155 was already considering projects of future fighters that would eventually replace this aircraft. To this end, NII-339 (alias NIIR – *Na**ooch**no-is**sled**ovatel'skiy insti**toot** **rah**diostro**yen**iya*, Radio Equipment Research Institute), a Ministry of Electronics Industry (MRP – *Mini**ster**stvo **rah**dioelek**tron**noy pro**mysh**len-nosti*) division, had begun development of a new weapons control system in keeping with a directive issued by the Communist Party Central Committee and the Soviet Council of Ministers. The WCS comprised a powerful Smerch-100 fire control radar and the K-100 long-range air-to-air missile.

Officially the experimental plant No.339 had been reorganised to become NIIR in 1962. Yet, for all practical purposes, the institute's establishment dates back to November 1958, when a team of engineers headed by Fyodor F. Volkov, a talented designer of airborne radars and missile radar seeker heads, came to work for OKB-339. In the early 1960s Volkov launched a large-scale research and development effort in search of new design principles for fire control radars intended for fighters. These included first and foremost the task of giving the fighters 'look-down/shoot-down' capability (that is, the ability to destroy targets flying below their own flight level, when ground clutter gives false radar returns, complicating target tracking and lock-on).

The Smerch-100 multi-purpose radar's project development stage was completed at the end of the 1960s. Among other things, Mikoyan's OKB-155 projected the Ye-155PA (MiG-25PA) heavy interceptor making use of this radar, K-100 AAMs and uprated R15BF-300 engines. The aircraft was to be capable of intercepting targets flying at altitudes of 100-30,000 m (330-98,420 ft) and speeds up to 4,000 km/h (2,484 mph).

Concurrently, OKB-115 headed by Aleksandr Sergeyevich Yakovlev and OKB-156 led by Andrey Nikolayevich Tupolev also worked on long-range heavy interceptor projects. In 1965 the Tupolev OKB completed the advanced development project (ADP) of the '148' (Tu-148) long-range interceptor built around the same Smerch-100 radar and K-100 AAMs as a prospective Tu-128 replacement. Like its forerunner, the Tu-148 was a fairly large aircraft, allowing a large-diameter radar scanner to be installed (the version of the Smerch-100 radar intended for the Tu-148 had a radar dish diameter of 2 m/6 ft $6\frac{3}{4}$ in). The MiG-25PA and the Tu-148 were intended primarily for protecting areas scarce in airfields and intercepting enemy bombers a long way from the Soviet borders – for example, above the Arctic Ocean as they came sweeping across the North Pole from the USA.

Yet, by the end of the 1960s, the Smerch-100 weapons control system no longer met the current requirements. In the USA, thanks largely to the introduction of state-of-the-art new technologies, a more capable weapons system comprising the AN/AWG-9 fire control radar and the AIM-54A Phoenix AAM had been developed and incorporated on the Grumman F-14A Tomcat shipboard interceptor. It allowed the interceptor to detect targets at long range, tracking more than 20 targets at a time while attacking several of them simultaneously. The potential adversary's offensive weapons systems were becoming increasingly more sophisticated, featuring new active electronic countermeasures (ECM) equipment for disrupting the work of not only AD radars but of fighters' fire control radars as well. Hence the top brass of the Soviet Ministry of Defence and the VVS, who were responsible for formulating the operational requirements for aircraft-based air defence systems, decided the time was ripe for a new aerial intercept system.

Development of the new-generation aerial intercept system, which received the designation S-155, was triggered by the joint Communist Party Central Committee/CofM directive No.397-152 of 24th May 1968. The system was intended first and foremost for countering the threat posed by the new-generation foreign strike and reconnaissance aircraft – that is, the General Dynamics FB-111A fighter-bomber and the Rockwell International AMSA (Advanced Manned Strike Aircraft), which eventually emerged as the B-1 bomber – by cruise missiles which, like the two abovementioned aircraft, were capable of ultra-low-level terrain-following flight, and by the Lockheed SR-71 spyplane capable of Mach 3 flight at 20,000 m (65,620 ft) and higher. The same directive tasked OKB-155 (which, after the death of Artyom I. Mikoyan, was now headed by his former first deputy Rostislav Apollosovich Belyakov) with designing and building an advanced version of the MiG-25 designated Ye-155M (*modifi***tsee***rovannyy* – modified, or *moderni***zee***rovannyy* – updated). Three variants (interceptor, tactical strike and reconnaissance) were envisaged.

Actually, as was often the case, development work on various elements of the S-155 aerial intercept system had begun some time ahead of the abovementioned directive; this included advanced development projects of all three versions listed above. Initially the aircraft was to be merely an upgraded MiG-25; by the early 1970s, however, the objective was somewhat different.

The Mikoyan OKB proposed developing the MiG-25PD into a long-range interceptor capable of patrolling alone over the vast northern wilderness and defending key industrial centres effectively. The aircraft was to have

RSK MiG

▲
General Designer Artyom I. Mikoyan and Merited Test Pilot Aleksey V. Fedotov (Hero of the Soviet Union), two men who contributed a lot to the development of OKB-155's new-generation interceptors. Judging by the look on their faces, they appear to be saying, 'Can we make a better aircraft than the F-14 over there, Artyom Ivanovich? – I'm sure we can.'

Rockwell International

▲
One of the reasons for the future MiG-31's development was the Rockwell International B-1 bomber. One of the B-1A prototypes is depicted here in a rather unusual camouflage scheme.

The small but highly capable General Dynamics F-111 Aardvark fighter-bomber was another potential adversary for the MiG-31.
▼

World Air Power Journal

long range and a top speed of about 3,000 km/h (1,864 mph) and to be capable of destroying multiple nuclear weapon delivery vehicles (including cruise missiles) in a single sortie. The crew was increased to two – the pilot and a navigator/weapons systems operator (WSO). The idea was supported by the government and the PVO command.

As already mentioned, three alternative general arrangements of the interceptor version bearing the manufacturer's designation Ye-155MP (*modifi**tsee**rovannyy pere**khvat**chik* – that is, Ye-155M, interceptor) were considered. Differing mainly in wing and vertical tail design, the fuselage structure and the MiG-25's characteristic lateral air intakes remained virtually unchanged. Version A had three-spar trapezoidal wings featuring small LERXes. Version B had variable-geometry wings, while Version C was the most unconventional, utilising a tailless-delta layout with ogival wings of increased area resembling those of the Tupolev Tu-144 supersonic transport (or rather those of the MiG-21I 'Analog' subscale technology demonstrator for the Tu-144).

The engineering team responsible for the development of the new interceptor included Gleb Ye. Lozino-Lozinskiy, V. A. Arkhipov, Konstantin K. Vasil'chenko and Anatoliy A. Belosvet. For the first time in Soviet fighter design practice it was decided to equip the fighter with afterburning turbofans – specifically, the D30F-6 developed by the Perm'-based OKB-19 under Pavel Alekseyevich Solov'yov – and all-new main landing gear units with multi-wheel bogies permitting operation from Class II (unpaved) airfields. Lozino-Lozinskiy was appointed chief project engineer, with Arkhipov as his deputy. The aerodynamic calculations and the subsequent support of the new interceptor's flight tests were the responsibility of Yu. S. Pakhomova, A. M. Ignat'yev, G. I. Davidenko, Z. F. Vanyushkina and A. V. Gorlov.

In parallel with the Ye-155MP interceptor version, which bore the in-house code *iz**del**iye* (product) 518, the Mikoyan OKB worked on the Ye-155MF tactical reconnaissance/strike version (F = *fronto**voy*** – 'frontline', used attributively; in this case, tactical) and the Ye-155MR pure reconnaissance version (R = [*samo**lyot**-*] *raz**ved**chik* – reconnaissance aircraft). The three versions were to differ mainly in armament and equipment. The original project envisaged side-by-side seating for the pilot and WSO under a canopy not unlike that of the Grumman A-6 Intruder. In order to obtain the required range and endurance the engineers initially gave priority to the 'swing-wing' version; for the same reason the fighter was originally to be powered by either the brand-new RD36-41M afterburning turbofans developed by Pyotr A. Kolesov at the Rybinsk-based OKB-36 or RD-19M afterburning turbofans. As the design work progressed, some of the radical innovations proposed initially (such as the VG wings) were rejected; yet the new fighter moved steadily away from the MiG-25 until eventually all they had in common was the general arrangement and similar dimensions.

In keeping with the same Communist Party Central Committee/CofM directive No.397-152 the NII-339 institute (NIIR) was tasked with developing the Ye-155MP's weapons system. This was to be a new-generation system enabling the interceptor to attack several targets at a time. At that time the MiG-25P's weapons system was at the closing stage of its trials. It included the RP-25 Smerch-A fire control radar developed by NII-339, with Fyodor F. Volkov as chief designer, and the seeker head for the K-40 semi-active radar homing (SARH) air-to-air missile redesignated R-40R after entering production. (RP = ***rah**diopri**tsel*** – 'radar sight'; this was the Soviet term for fire control radars.) For the first time in the world Ye. Ghenishta, the project chief of the missile's seeker head, had made use of the monopulse radar data processing method which markedly improved the missile's guidance accuracy and ECM resistance. At the same time NII-339 was going full steam ahead with the development of the RP-23 Sapfeer-23 (Sapphire-23) radar and the PRGS-23 semi-active radar seeker head (poluaktivnaya rahdiolokatsionnaya golovka samonavedeniya) intended for the new MiG-23 *Flogger* tactical fighter; work on the *Tai**foon*** (Typhoon) radar for the Sukhoi Su-15T interceptor had also begun. The new assignment, coupled with these current programmes, was more than NII-339's team could handle.

Hence in 1969 the Ministry of Electronics Industry decided to resume fire control radar design work at the Zhukovskiy-based OKB-15 (alias *KB **rah**diostro**yen**iya*, Radio Equipment Design Bureau) and merge this establishment with NII-339 in order to pool resources. The new entity was renamed NPO Fazotron (*na**ooch**no-proiz**vod**stvennoye ob'ye-di**nen**iye* – 'Phasotron' Scientific & Production Association). Yuriy N. Figurovskiy was appointed General Director and General Designer, with V. K. Grishin as his first deputy and Chief Designer; the two also became the top executives of NIIR. Thus the two R&D establishments that had sprung up in 1958, when NII-17 split in two, were reunited. The new enterprise set to work developing a new multi-channel long-range aerial intercept system built around the Ye-155MP interceptor and the K-33 AAM; the system was designated *Za**slon*** (Shield, or Barrier).

NPO Fazotron – to be precise, its Zhukovskiy branch (the Radio Equipment Design Bureau) – was assigned responsibility for the entire weapons control system (WCS) of the Zaslon aerial intercept system, including the radar and the K-33 missile's seeker head. The missile itself was developed by the ***Vym**pel* (Pennant) Design Bureau which was then headed by A. L. Lyapin; Yu. K. Zakharov was the K-33's project chief. The integration of the Zaslon aerial intercept system's compo-

Lockheed Martin

▲
For years the Mach 3 Lockheed SR-71 Blackbird was the bane of the Soviet Air Defence Force's existence. Yet, the Blackbird's creators could hardly have foreseen that the Soviet Union would eventually develop an 'anti-Blackbird' in the shape of the MiG-31.

RSK MiG

▲ **Rostislav A. Belyakov became head of the Mikoyan OKB after its founder's death and contributed immensely to the development of the MiG-31. Here he is seen with the two Gold Star Orders that go with his two Hero of Socialist Labour titles.**

nents (that is, development of their interaction principles and the determining of the components' performance targets) was the domain of the State Research Institute for Aircraft Systems (GosNII AS – *Gosoo**dar**stvennyy na**ooch**no-is**sled**ovatel'skiy insti**toot** aviatsi**on**nykh sis**tem***), one of the Soviet aircraft industry's key R&D establishments.

For the first time in Soviet practice, the enterprise designing the fire control radar held overall responsibility for the future interceptor's entire armament system due to the need to integrate its operational modes. It may well be said now that this approach paid off completely, allowing the system's design features to be carefully optimised.

The design philosophy of the Zaslon system was markedly different from that of its US counterparts. The Soviet system was designed for territorial air defence of a nation where airbases and air defence system electronic installations were scarce. This necessitated an enhanced ability to operate independently, longer detection/intercept ranges and the ability to protect larger areas, and multi-channel targeting capability for the entire ordnance load carried by the aircraft.

The first task the designers took on was to work out ways of giving the radar 'track-while-scan' and multiple target attack capability. Existing radars with mechanically scanned antennas lacked this capability. The AN/AWG-9 – the most powerful and refined radar in its class – was an exception, but even it could track several targets and guide missiles to them only within a very narrow sector.

Since the Ye-155MP interceptor was supposed to be armed with four K-33 long-range SARH missiles, the objective was to give it the ability to attack four targets at once. Since high-priority threats had to be identified and attacked first, the number of simultaneously tracked targets had to be greater than four. The maximum number (ten) was determined by the sum of the time periods needed for tracking each target and by the scanning time.

The width of the scanned area was to ensure coverage of a zone 200 km (124 miles) wide measured at the radar horizon; in this case a flight of four interceptors could cover an area up to 800 km (496 miles) wide. The detection range against a target with a radar cross-section (RCS) of 19 m^2 (204.3 sq ft) – which matches that of the SR-71, one of the toughest targets to intercept for the Soviet PVO – was to be 180-200 km (111-124 miles), that is, several times longer than for any Soviet interceptor type then in service.

After analysing possibilities open to them, in 1969 the designers of the Ye-155MP's weapons control system took an extremely daring decision by the day's standards: the radar antenna would be fixed and the beam would be scanned electronically. This was another 'world's first' – such systems had not been used hitherto on fighters and the task was extremely complex. (It may be noted that phased-array radars using an electronically scanned beam would be used on some Western aircraft, including the B-1B bomber and the Lockheed TR-1 high-altitude reconnaissance aircraft, from the early 1980s. However, all the early Western phased-array radars were designed for ground mapping, not for aerial intercept.)

RSK MiG (both)

▲ Gleb Ye. Lozino-Lozinskiy (left) was the Ye-155MP's first project chief, with Vasiliy A. Arkhipov (right) as his deputy. Their role in the development of the MiG-31 cannot be played down.

Development of the phased-array antenna for the Zaslon system was led by chief designer B. I. Sapsovich and NPO Fazotron's chief engineer S. A. Pecherin. The latter not only organised production of the new type of antenna but also managed to convince the decision makers in the government that phased-array radars offered major advantages and should be developed. NPO Fazotron's Chief Designer V. K. Grishin exer-

RSK MiG (both)

◄◄ Konstantin K. Vasil'chenko.

◄ Anatoliy N. Belosvet. These two OKB-155 designers were heavily involved in the MiG-31's development from the outset.

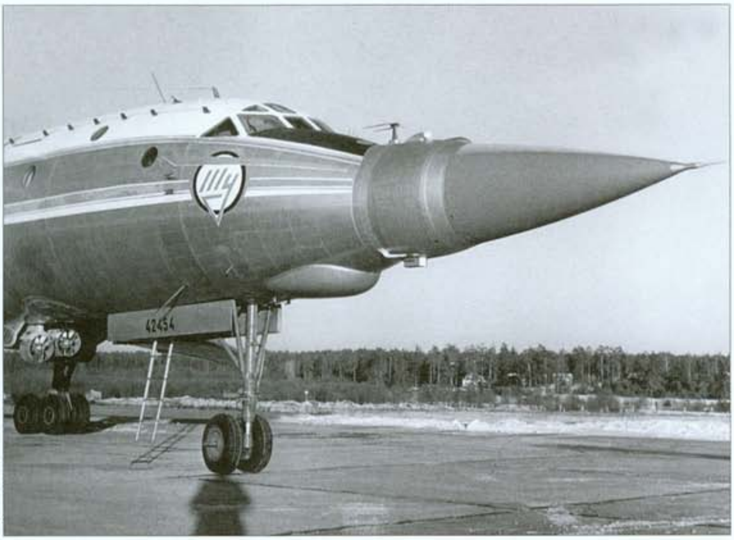
The photos on this page depict Tu-104B CCCP-42454 which was used by the Flight Research Institute (LII) as an avionics and weapons testbed for the MiG-31. The Zaskin radar was installed in place of the navigator's station, while modified pylons from a Tu-16K missile carrier (with launch rails) were fitted for carrying K-33 AAMs. A test launch of a K-33 is pictured on the right. Note also the ram air turbine-driven generators and test equipment heat exchanger under the forward fuselage. ▼

cised overall scientific and technical direction, while integration issues were handled by A. I. Fedotchenko, Chief Designer of the Zaslon WCS. A major contribution was also made by Yuriy I. Belyy who later became head of the breakaway NIIP.

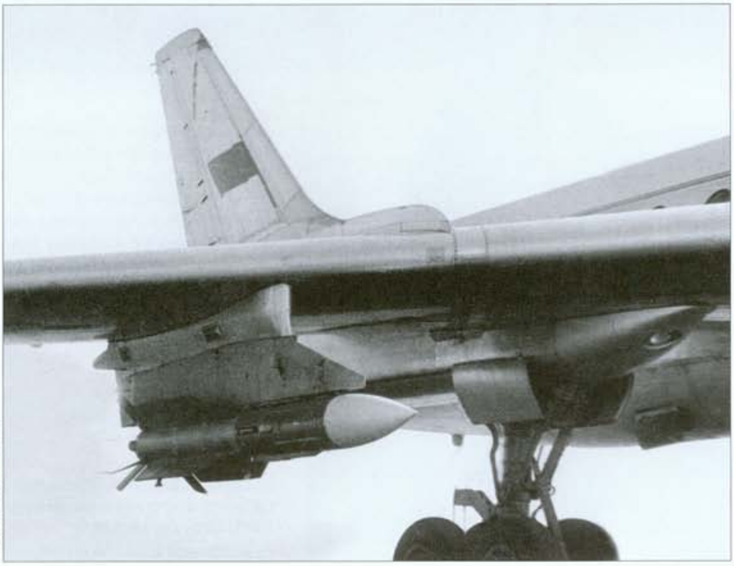
A lengthy quest by trial and error followed as various engineering solutions were tested and rejected. It was not until 1975 that a satisfactory phased-array antenna – the fourth version developed – was available for testing on an actual aircraft (an avionics testbed).

For the first time in the world's airborne radar design practice, a long-range fire control radar incorporated a three-channel (search, target tracking and identification friend-or-foe) antenna system and a digital processor with narrow-band Doppler filtration. The antenna was a monobloc phased array featuring rapid electronic beam scanning. Other 'firsts' for a Soviet interceptor included the WCS's pulse-Doppler data processing, continuous sampling target illumination, a tactical information display and a digital data processing system based on the A-15A (***Argon**-15*) mainframe computer developed by the Electronic Computing Equipment Research Centre (NITsEVT – *Na**ooch**no-is**sled**ovatel'-skiy tsentr elek**tron**no-vychis**lit**el'noy **tekh**niki*). This computer, which was later built in quantity in Kishinyov, Moldavia, was not particularly fast, to say the least (the maximum speed was 200,000 short operations per second); yet it was the only indigenous compact digital computer available at the time, so it was basically a 'take it or leave it' choice. At that time the A-15A mainframe computer was used on 50 types of Soviet military hardware.

On the other hand, the phased-array antenna (designated B1.01M in production form) remains something of a 'golden standard' to this day as far as the basic emission parameters are concerned. It was the world's first radar antenna capable of working in two wavebands (X-band and L-band); in effect, it consisted of two separate phased arrays, one for each waveband, integrated into each other and giving a scan angle of ±60°. (It should be



Flight Research Institute



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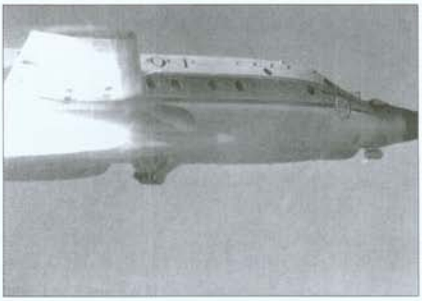

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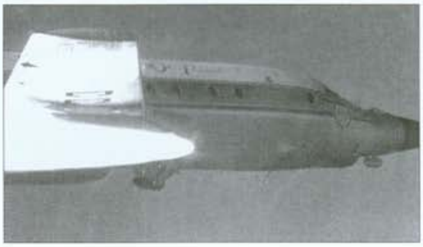


Flight Research Institute

noted that the first Western fighters to feature phased-array radars – the Dassault Rafale and the Mitsubishi F-2, both of which represent the so-called Generation 4 Plus – entered production in the 21st century, when the subject of this book had already been in service for two decades.)

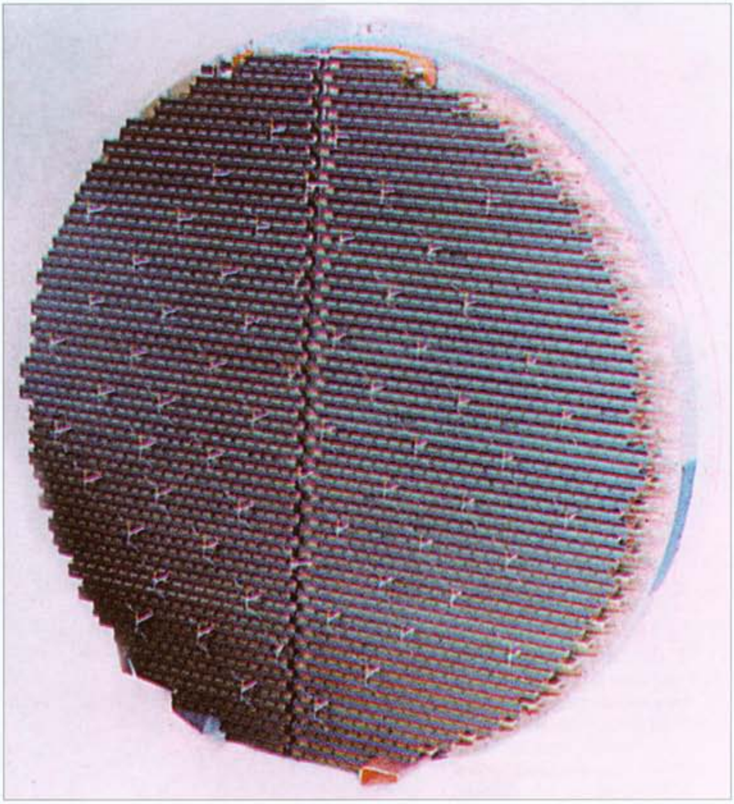
The radar forming the core of the Zaslon WCS (it received the product code 8B in its production form) consisted of the following subassemblies:

- a transmitter;
- a receiver;
- a pulse generator with a synchronisation system;
- an interface for integration with the aircraft's other avionics;
- a digital data processing system;
- a data recording system used for status monitoring and mission debriefing.

Inevitably, since NPO Fazotron was breaking new ground with the Zaslon system, the complexity of the task to be solved and the lack of prior experience led to errors, and design shortcomings came to light during the development and test phase. The unsatisfactory units had to be redesigned and new prototype modules manufactured.

The main difficulties encountered in designing phased-array radars consisted in ensuring the required low noise level for the transmitters and wide dynamic range for the receivers, as well as ensuring target detection and tracking at various ranges. As designers' ideas changed in the course of the radar's development, so did the design. Seven variants of the phased-array antenna were developed, manufactured and tested consecutively; the best of them had an area use quotient of 0.45-0.5 within a broad frequency range. The theoretical principles of phased-array antenna design were formulated and new phased-array antenna design techniques evolved; these included special software for calculating the antenna's parameters on a computer.

When designing the radar's transmitters the engineers at NPO Fazotron relied on the experience gained with the S-75 Koob (Cube) surface-to-air missile system where the missile's seeker head worked in continuous emission mode and the target illumination channel was characterised by a low noise level. Unlike the SAM's guidance system, however, the future interceptor's fire control radar was to operate in pulse mode and use a much broader frequency band, and the noise level was required to be even lower. A major problem that had to be solved was that the harmonics of the transmitter's signal lay within the receiver's Doppler range, creating false radar returns.


NPO Fazotron

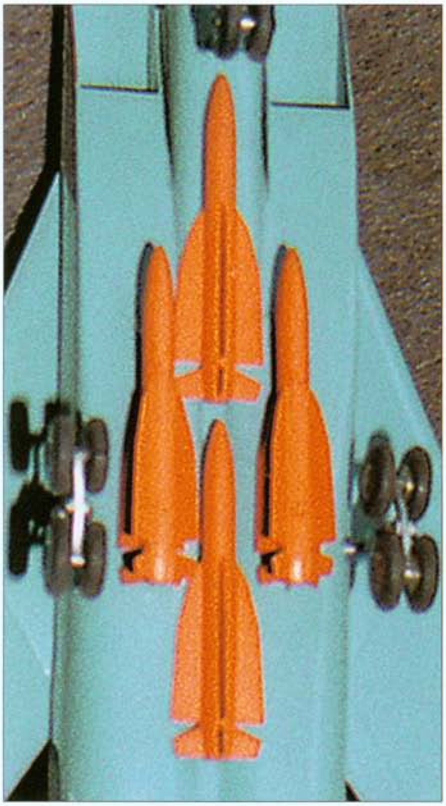
▲
The B1.01 phased-array antenna of the Model 8B fire control radar fitted to the MiG-31.

Another problem was that the powerful vacuum tubes used in the radar's transmitter turned out to be rather troublesome. Work on improving the reliability of these components (and of the transmitter as a whole) continued unabated. Four versions of the transmitter for the Zaslon system's radar had to be designed and tested until the results were satisfactory.

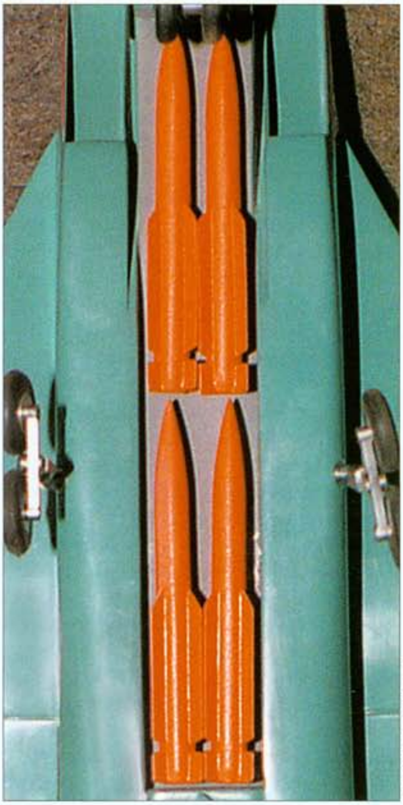
The data processing system of the Zaslon was built around the A-15A (Argon-15) digital mainframe computer which was responsible for the radar's functions, among other things. The Radio Equipment Design Bureau developed a digital databus linking the mainframe computer with all other components of the WCS; the Ye-155MP was the first Soviet fighter to feature such a databus.

A complete and fully operational radar was installed in an anechoic chamber at GosNII AS together with an electronic device emulating radar returns which was linked to the radar's pulse generator; this device, codenamed

▶
An early desktop model showing a provisional arrangement of the K-33 AAMs under the fuselage of the Ye-155MP.

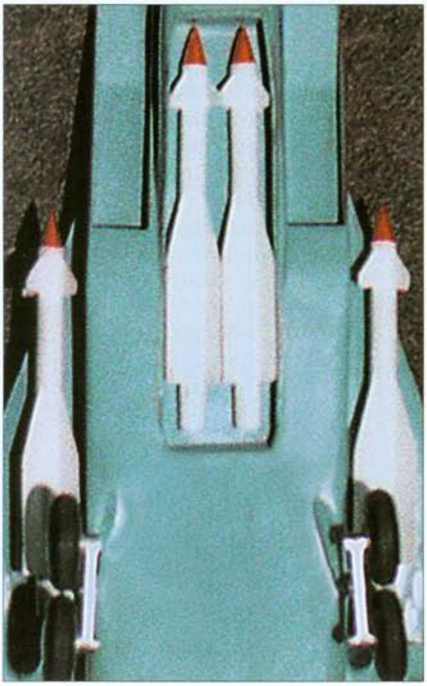


▶▶
Another provisional model with the K-33s arranged in side-by-side pairs in a large recess in the interceptor's belly – almost an internal weapons bay. Not only did this require changes to the airframe and the landing gear (note the narrower air intakes and the twin-wheel main gear bogies instead of four-wheel units) but the missiles are also rather different, featuring shorter and recontoured fins and rudders.



Yefim Gordon (all three)

▶
Yet another desktop model showing how the Ye-155MP would have looked with K-100 missiles. Note the considerably shorter weapons bay.



Ookrop (Dill), was specially developed for the Zaslon system. This testing technique allowed the system's operation to be verified. Ground test rigs at GosNII AS also served for carrying out the radar's ECM resistance trials almost in full; new design features making new-generation radars more resistant to ECM were evolved and verified at the same time.

The Zaslon weapons control system – to be precise, the radar making up the core of the system – was to detect targets with an RCS of 16 m^2 (172.0 sq ft) at a maximum range of 200 km (124 miles). Maximum tracking range for a medium bomber-sized target – such as the Tupolev Tu-16 bomber – was to be 120 km (74.5 miles); maximum tracking range for a fighter-type target was to be 90 km (55.9 miles) in head-on mode and 70 km (43.5 miles) in pursuit mode. The Zaslon WCS was to enable concerted action by a flight of interceptors when target information was intermittent or limited to a single report; this would allow the aircraft to operate in areas only partially covered by AD radars.

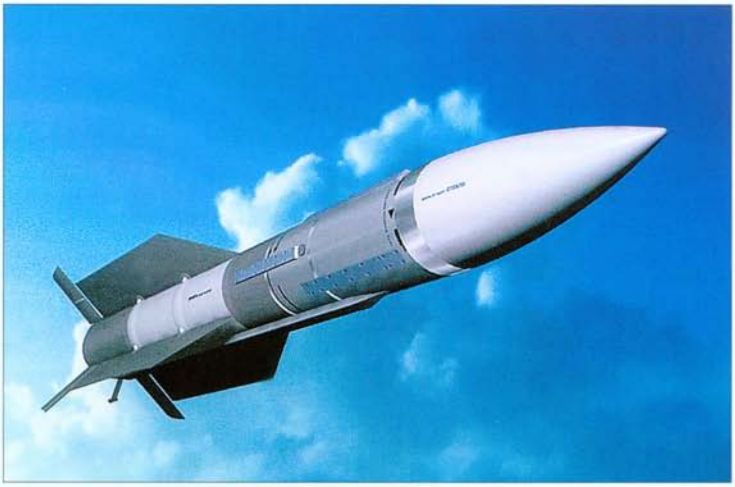
Thus the Soviet Air Defence Force received the capability to repel massive enemy air raids (including those carried out at low altitude), the interceptors attacking their targets in head-on and pursuit modes. New techniques of attacking enemy aircraft in an ECM environment were implemented, as was the ability to guide other Soviet fighters featuring less sophisticated radars to aerial targets (the Ye-155MP was to act as an airborne early warning and command post). Other advanced combat functions included the possibility of two interceptors simultaneously attacking a top-priority threat and the possibility of transferring the guidance of a missile fired by one interceptor to another aircraft.

While in a head-on attack success depended largely on the performance of the interceptor's radar, during an attack in pursuit mode the adversary could be alerted by his radar homing and warning system (RHAWS) that he was under attack even before the interceptor had a chance to fire. After that, the target could switch on its active ECM system, negating the efficiency of the interceptor's radar. To increase the chances of a 'kill' the designers of the Zaslon weapons control system utilised a layout already used on other interceptors, supplementing the fire control radar with an infra-red search & track unit.

Development of the Ye-155MP's IRST (known as 8TP in production form; TP = ***tep**lopelen**gah**tor* – heat seeker) was 'subcontracted out' to the Gheofizika Central Design Bureau led by D. M. Khorol' in 1970. (The designation 8TK (*teplo**voy** ka**nahl*** [*sis**tem**y nave**den**iya*] – IR channel of the guidance system) was also quoted.) The main function of the IRST was to enhance the interceptor's stealth by allowing it to launch an attack in pursuit mode without revealing itself by switching on the radar. It was assumed that, after the aircraft had been guided within range of the target by an automated ground controlled intercept (GCI) system, the IRST would detect the target and track it with sufficient accuracy for launching IR-homing missiles.

The specifications to which the 8TP was designed envisaged that the IRST would only be used at high altitude. Hence the unit was installed in a cylindrical housing that was normally stowed in the forward fuselage underside, swinging down into the airstream when activated. A drum with a set of mirrors revolving in one direction focused the thermal image on a heat sensor cooled by liquid nitrogen.

Prototypes of the 8TP IRST commenced bench testing in 1977. Target tracking dynamics and infra-red countermeasures (IRCM) resistance were assessed, including the ability to single out a target in a group (that is, to discern between the real target and IRCM decoys) against various backgrounds. Building on the results of these tests, the system's hardware and software were progressively refined. (It may be said now that the trials programme was completed in 1980 and the 8TP IRST was officially adopted by the Soviet Air Force in 1981 as part of the MiG-31's avionics suite.)


Vympel

▲ **The R-33 long-range AAM in its ultimate form – the MiG-31's principal weapon. Note the longer span of the folding rudders and the lateral antennas immediately ahead of the fins.**

Debugging of the Zaslon WCS was performed by the Radio Equipment Design Bureau with the assistance of GosNII AS and of NPO Fazotron's other divisions. Generally the order was as follows: the modules of the radar set were tuned and delivered to the 'customer', then the various completed subsystems were tuned, whereupon the subsystem was tested on a ground rig at the Radio Equipment Design Bureau and finally at GosNII AS. Additionally, the systems were tested in flight on avionics testbeds.

Speaking of testbeds, the Zaslon WCS was put through its paces on two Tupolev Tu-104 twinjet medium-haul airliners suitably converted by NPO Vzlyot (Take-off), another notable avionics house. Since the radar was installed in a large conical radome supplanting the Tu-104's glazed navigator's station, these aircraft earned the sobriquet *Boora**tino*** (the Russian equivalent of Pinocchio), courtesy of Air Marshal Yevgeniy Ya. Savitskiy. The first aircraft, which entered flight test in the spring of 1973, served for perfecting the function of controlling the phased-array antenna and refining the target search and detection process. The second 'Pinocchio', which

▶ **Academician Yevgeniy A. Fedosov, Director of GosNII AS. As was often the case, the institute's input was decisive in shaping the weapons system of the new interceptor.**

GosNII AS

joined the first aircraft in the autumn of 1975, was generally intended for verifying the Zaslon WCS as a whole, although initially it, too, served for verifying various functions (including target detection and tracking).

The radar's integration with the K-33 missiles' seeker heads was performed at a later stage. This time it was not a Tu-104 but a number of fast combat aircraft that served as the avionics/weapons testbeds; this stage of the tests involved actual missile launches. Unexpectedly, the equipment, which functioned beautifully on the ground, often refused to work on the combat jets; it eventually transpired that the operation of the WCS's components was affected considerably by how they were located on the actual aircraft.

As already mentioned, GosNII AS was responsible for integrating the elements of the S-155 aerial intercept system and supporting the development of the Ye-155MP interceptor, the Zaslon WCS and the K-33 missile. The greatest contribution to the institute's involvement in the S-155 programme was made by the laboratory under I. B. Tarkhanov (who also had overall responsibility for the programme) and by Section 2 employees V. S. Zinich, L. Ye. Shirokov, O. L. Perov, L. Ye. Bakhanov, A. R. Lanskiy and V. A. Orlov. Work on the K-33 AAM was performed by Section 4 (R. D. Kooz'minskiy, A. S. Sinitsin *et al*). The work performed by GosNII AS included development of working algorithms for the WCS and other mission avionics, and assessment of the S-155 aerial intercept system's combat capabilities. Later the institute performed systems development work by mathematical analysis and on ground rigs – both before and in the course of the interceptor's state acceptance trials; it also analysed the test results and drew conclusions.

A major achievement made by the creators of the S-155 aerial intercept system was the large-scale automation of the interceptor's GCI guidance, target attack and control modes throughout the mission. The automation of trajectory plotting and following allowed all possible aircraft/weapon guidance modes to be implemented and the interception range to be maximised for targets flying within a wide range of speeds and altitudes.

In order to solve the completely new and extremely complex tasks of debugging the interceptor's mission avionics, verifying combat modes, performing systems integration and assessing the aircraft's combat potential the institute's Section 2 developed and built the new KPM-1550 ground test and simulation complex (***kom**pleks **pol**una**toor**novo modelee-rovaniya*). This involved the assistance of the institute's Sections 9 and 11, as well as the avionics' designers (NIIR). The KPM-1550 served as the prototype for subsequent generations of avionics test and simulation complexes, laying the foundation of a well-developed network of means for testing and integrating the avionics developed for Soviet fighters in the 1980s and 1990s.

For the first time on a Soviet fighter, computers were used in the Zaslon WCS, the automatic flight control system and the navigation suite; these were verified on the KPM-1550 installation, as was the cockpit indication system. Among other things, the specialists working at GosNII AS's Section 2 participated in the development of techniques for a coordinated multiple-aircraft attack, working out the algorithms and writing the software that allowed the aircraft's computer to prioritise targets and assign the order in which they were to be attacked by a group of interceptors. The same team also worked on the group leader's tactical information display and selected the most rational tactical information presentation modes.

The KPM-1550 ground test and simulation complex was used both for demonstration purposes (that is, to impress various Soviet Government, MoD and Communist Party bosses who were given a 'ride' in the as-yet non-existent aircraft) and for training test pilots and navigators from the Mikoyan OKB and the Red Banner Soviet Air Force Research

Institute (GNIKI VVS – *Gosoo**dar**stvennyy **kras**nozna**myon**nyy na**ooch**no-is**sled**ovatel'skiy insti**toot** Vo**yen**no-voz**doosh**nykh seel*).

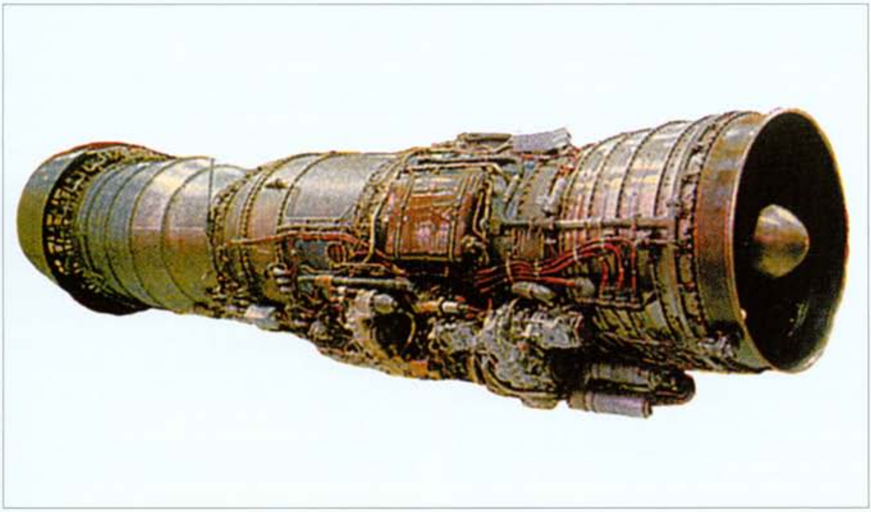
The multi-aspect job of creating and verifying the Ye-155MP interceptor's systems and assessing its combat potential was handled by several GosNII AS sections – Nos 2 (which did the main part of the job), 4, 1, 13, 9 and 10. It involved a large group of top-notch specialists, many of whom were later awarded government decorations for their contribution; project leader I. B. Tarkhanov received the State prize for this programme in 1981.

As already noted, the K-33 missile was developed by the Vympel OKB headed by A. L. Lyapin, with Yu. K. Zakharov as project chief. This ultra-long-range AAM featured semi-active radar homing (SARH) and folding fins; the latter feature allowed the missile to be carried semi-recessed in the fuselage underside. The SARH seeker head achieved target lock-on after the missile had been fired; until then the missile was guided by an inertial system (the inertial guidance phase made up 10-20% of the trajectory length). The K-33 was to make large-scale use of titanium alloys; the launch weight was 491 kg (1,082 lb), including 55 kg (121 lb) for the warhead. The maximum effective 'kill' range was 120-130 km (74.5-80.75 miles); the missile was to be effective against targets flying at altitudes of 50-28,000 m (164-91,860 ft) and speeds up to 3,700 km/h (2,300 mph) and the 'kill' probability against a target making 4G evasive manoeuvres was 60 to 80%.

GosNII AS also undertook R&D work on the K-33; this was originally done by a team led by Ye. M. Bausin but later passed to another team. The intensity of the research peaked in 1974-79 when A. S. Sinitsin supervised it; other participants of the programme included Ye. A. Sevast'yanov, B. N. Sel'yanov, M. Kh. Aisin, V. T. Pekov, A. M. Ivanov, I. V. Kashevarova *et al*. The institute performed extensive mathematical analysis and bench testing of the missile's seeker head; the missile's control system was put through its paces on a dynamic test rig and the guidance system's interaction with the interceptor's mission avionics checked out. Concurrently GosNII AS assessed the combat efficiency of both the K-33 missile (as a constituent part of the S-155 aerial intercept system) and the system as a whole; this job was handled by Section 2 under the direction of Ye. I. Chistovskiy, P. V. Poz'nyakov, I. B. Tarkhanov, O. L. Perov and others.

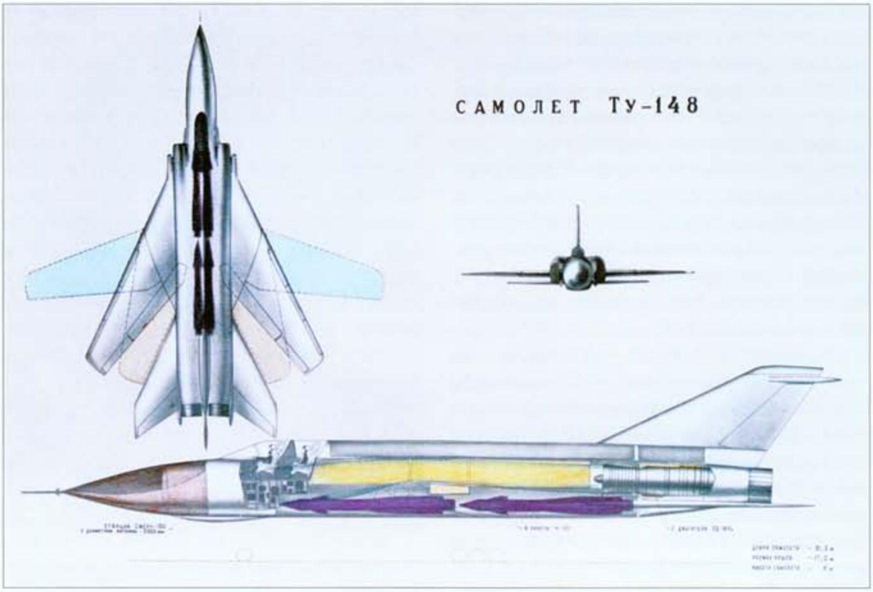
Meanwhile, work on various components of the S-155 aerial intercept system proceeded at dozens of other design bureaux and research establishments of several industry branches. Thousands of specialists and shop floor workers were involved in the creation of this system – a task of paramount importance.

Coming back now to the development of the interceptor itself, one of the crucial requirements was the ability to destroy low-flying cruise missiles at long range. The reason was that the cruise missiles could be equipped with nuclear warheads, and a possible detonation of such a warhead would wipe out the attacking interceptor or SAM site at several miles' range.



Yefim Gordon archive

◄ **The Solov'yov D30F-6S afterburning turbofan.**

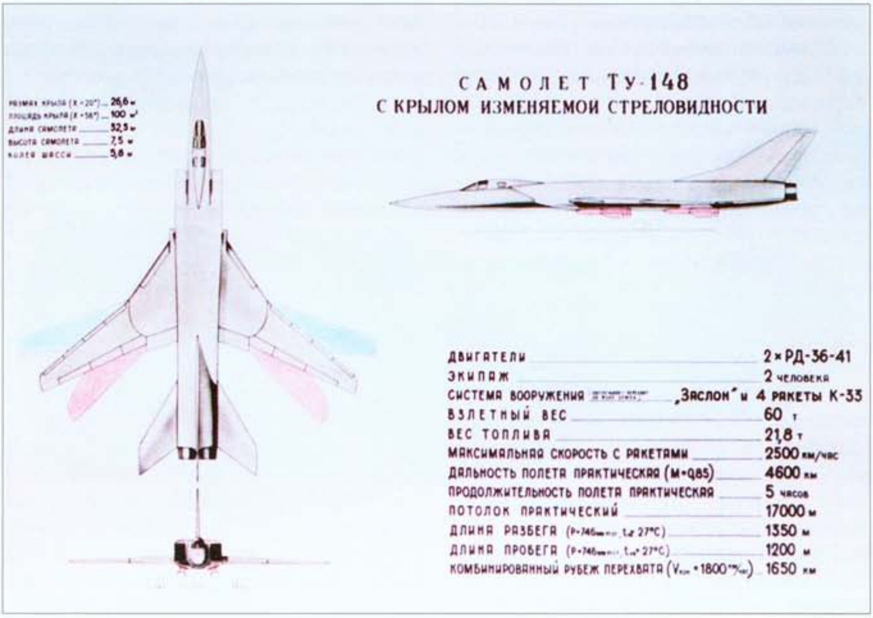


▶ **The competing Tu-148 heavy interceptor with variable geometry wings was developed by Andrey N. Tupolev's OKB-156. This three-view represents an early project configuration featuring the Smerch-100 weapons control system and armed with four semi-recessed K-33 missiles. The rather sluggish-looking aircraft resembles the F-111, apart from the mid-set wings and tandem cockpits.**

Tupolev JSC

The key factors shaping the Ye-155MP's design were:

- the availability of the new Solov'yov D30F afterburning turbofan having much better fuel efficiency as compared to contemporary Soviet fighter engines, especially in subsonic flight modes;
- the development of the Zaslon WCS featuring a phased-array radar and the A-15A Argon digital mainframe computer. As compared to the RP-23 Sapfeer-23 radar fitted to the MiG-23 tactical fighter, the new radar offered twice the detection range, plus large scanning angles in both azimuth and elevation, the ability to track ten targets (which were shown on the tactical information display) and guide K-33 long-range missiles to four of them. Priority targets were designated automatically (as per the parameters entered into the computer) or manually by the crew;



РАЗМАХ КРЫЛА (χ = 20°)	26,6 м
ПЛОЩАДЬ КРЫЛА (χ = 56°)	100 м²
ДЛИНА САМОЛЕТА	32,5 м
ВЫСОТА САМОЛЕТА	7,5 м
КОЛЕЯ ШАССИ	5,6 м

ДВИГАТЕЛИ	2 × РД-36-41
ЭКИПАЖ	2 человека
СИСТЕМА ВООРУЖЕНИЯ	„Заслон" и 4 ракеты К-33
ВЗЛЕТНЫЙ ВЕС	60 т
ВЕС ТОПЛИВА	21,8 т
МАКСИМАЛЬНАЯ СКОРОСТЬ С РАКЕТАМИ	2500 км/час
ДАЛЬНОСТЬ ПОЛЕТА ПРАКТИЧЕСКАЯ (М=0,85)	4600 км
ПРОДОЛЖИТЕЛЬНОСТЬ ПОЛЕТА ПРАКТИЧЕСКАЯ	5 часов
ПОТОЛОК ПРАКТИЧЕСКИЙ	17000 м
ДЛИНА РАЗБЕГА (P=746 мм рт ст, t=27°C)	1350 м
ДЛИНА ПРОБЕГА (P=746 мм рт ст, t=27°C)	1200 м
КОМБИНИРОВАННЫЙ РУБЕЖ ПЕРЕХВАТА (V = 1800 км/ч)	1650 км

▶ **A rather more elegant later project version of the Tu-148 looking like a scaled-down Tu-22M34 bomber. This version was to feature the same Zaslon weapons control system and the same K-33 missiles as fitted to the MiG-31.**

Tupolev JSC

- the availability of the new K-33 long-range AAMs;
- the greatly enhanced air-to-ground and aircraft-to-aircraft data exchange capabilities;
- the increased mission time (on-station loiter time) and the accordingly increased crew workload which necessitated the provision of a second crew member – the weapons systems operator;
- the provision of new navigation equipment, including an inertial navigation system;
- the provision of more advanced communications and identification friend-or-foe (IFF) equipment.

In fairness, it should be noted that the Tupolev OKB also offered a version of its projected Tu-148 heavy interceptor featuring the Zaslon WCS and the K-33 AAMs. Designated Tu-148-33, this aircraft was intended for destroying enemy aircraft flying at up to 3,500 km/h (2,138 mph) and 26,000-28,000 m (85,300-91,860 ft). Yet in the early 1970s the Soviet military expressed their preference for an in-depth modernisation of the MiG-25P to take the Zaslon WCS.

Full-scale design work on the Ye-155MP at the Mikoyan OKB began in 1972. In its specific operational requirement for the new interceptor the Air Force demanded above all an increase in range and endurance (on-station loiter time); on the other hand, the speed and service ceiling target figures were almost unchanged as compared to the MiG-25P. The aircraft was to have a maximum interception range of 700 km (434 miles) when cruising at 2,500 km/h (1,552 mph) or Mach 2.35; at subsonic speed the maximum interception range was extended to 1,200 km (745 miles). The envisaged automated data link/tactical information exchange system was to enable groups of fighters to control the vast stretches of Soviet territory in the High North and Far East lacking adequate coverage by AD radars. Realising the high complexity of the Zaslon WCS, the military consented to an increase in the number of crew members. Of course it would be utterly impossible for a single pilot to fly the aircraft while keeping an eye on the tactical situation, monitoring the aircraft's numerous systems and taking decisions whether to attack the target or not; the WSO would take over some of these functions, allowing the pilot to concentrate on the flying.

As already mentioned, the requirements of ensuring the specified range and endurance coupled with adequate speed performance were met by installing D30F-6 afterburning turbofans developed by OKB-19 under Pavel Alekseyevich Solov'yov in Perm'. The D30F-6 (*for**see**rovannyy* – uprated or, as in this case, afterburning) was derived from the 6,800-kgp (14,990-lbst) D-30 Srs 2 non-afterburning turbofan powering the Tu-134A/Tu-134B short/medium-haul airliner. By installing an afterburner and making other changes the OKB managed to increase the maximum thrust to 15,500 kgp (34,170 lbst).

Design work began in 1972. Three years later the Mikoyan OKB extensively modified two *Foxbats* – a MiG-25P interceptor and a MiG-25RB reconnaissance/strike aircraft – into engine testbeds powered by D30F-6s. The conversion involved increasing the cross-section of the engines' inlet ducts, since the D30F-6s had a greater mass flow than the MiG-25's standard Tumanskiy R15B-300 afterburning turbojets. Designated *izdeliye* 99, the testbeds received new construction numbers (990001 and 990002) and were appropriately coded '991 Blue' and '992 Blue' respectively.

(Note: Unlike Western military aircraft, which have serials allowing positive identification, since 1955 Soviet (and subsequently CIS) military aircraft have two-digit tactical codes which, as a rule, are simply the aircraft's number in the unit operating it, making positive identification impossible. Three- or four-digit codes are usually worn by development aircraft (in which case they still tie in with the c/n or the manufacturer's line number, or refer to an in-house designation) or aircraft serving with training units. On military transport aircraft, however, three-digit tactical codes are usually the last three of the former civil registration; many Soviet/Russian Air Force transports were, and still are, quasi-civilian.)

The engine entered quantity production at the Perm' Engine Production Association (PPOM – ***Perm****skoye proiz***vod***stvennoye obyedi***nen***iye mo***tor***ostro***yen***iya*) in 1976 as the D30F-6S (the S suffix stood for *se***reey***nyy* – production, used attributively) and completed joint state acceptance trials in 1979. ('Joint' means that they were held jointly by the manufacturer – in this case, OKB-19 – and the customer.)

The designers of the K-33 missile and the aircraft's navigation and targeting suite had to tackle a host of tough engineering problems. A peculiarity of the K-33's guidance system was that the missile featured an inertial navigation system (INS) which guided it during the initial phase of the flight until the radar seeker head got a lock-on. Thus the accuracy of the missile was affected not only by the operation of the radar seeker head but also by INS errors which, in turn, depended in no small degree on the accuracy of the launch point co-ordinates fed into the INS. In turn, the errors on the launch point co-ordinates were affected by the error margins of the aircraft's navigation and targeting suite, which needed to be minimised. To make matters worse, there was another task which the designers of the navigation and targeting suite had to solve, namely navigation in the Polar regions. The general belief is that determining one's position and plotting the correct course near the North Pole is complicated by the unreliable operation of the magnetic compass in these high latitudes, but in reality things are much more complicated.

The Ye-155MP's requisite long endurance created another stumbling block: the accuracy of the INS was directly affected by the period of its operation. As time passed, the INS started generating errors which sometimes could not be corrected by means of celestial or satellite navigation. Hence new high-precision primary data sensors (gyros and accelerometers) were needed to ensure the required accuracy of the INS.

Sure enough, the designers managed to sort out all of these numerous and often conflicting requirements, but a side effect of this was that the interceptor's navigation suite turned out to be not only effective but highly complex as well. At the test and debugging stage the navigation suite caused a lot of aggravation for both its creators and the test crews. Apart from the INS, the nav/attack suite included long- and short-range radio navigation systems (LORAN and SHORAN) and an air data system. This combination of subsystems utilising differing physical principles allowed overall navigation accuracy to be increased considerably thanks to a specially developed data processing algorithm.

The interceptor's navigation suite included the SAU-155MP automatic control system (*sis***tem***a avtoma***tich***eskovo oopravl***en***iya*) and the KN-25 integrated navigation system (kompleks navigatsionnyy). The latter consisted of two IS-1-72A inertial navigation systems, a *Ma***nyovr** (Manoeuvre) digital processor, an A-312 *Radi***kal***-NP* SHORAN, an A-723 *Kvi***tok-2** (Receipt-2) LORAN, and Tropik and *Marsh***root** (Route) global positioning system receivers. A defensive avionics suite comprising electronic countermeasures (ECM) gear and active/passive infra-red countermeasures (IRCM) gear for protection against radar-homing and heat-seeking missiles respectively was also envisaged.

Integration of the various avionics modules with the airframe and with each other was performed by Mikoyan OKB engineers V. V. Solopov, O. P. Beloborodov, K. V. Badanova, Ye. N. Yefimov-Sosnovskiy, N. V. Goryacheva, I. V. Sergeyev and G. I. Rabinovich. Team 1056 of Section 105, which was responsible for systems theory research and was headed by A. A. Goryachev, developed the operational and control algorithms for the interceptor.

For close-in combat the Ye-155MP was to be armed with a 23-mm (.90 calibre) Gryazev/Shipoonov GSh-6-23 six-barrel Gatling cannon with 260 rounds. It had a linkless ammunition feed system and a normal rate of fire of 6,000 ±500 rounds per minute which could be increased to 8,000 rpm in case of need. The muzzle velocity was 700 m/sec (2,300 ft/sec). The GSh-6-23 cannon was to be mounted on the side of the starboard air intake trunk, just aft of the starboard main landing gear unit.

The new method of accommodating the largest missiles in the Ye-155MP's weapons range – the K-33 AAMs were to be carried in tandem pairs semi-recessed in the belly – cut the aircraft's overall drag considerably. During launch the missiles were to be ejected vertically downwards by pantographic carriers/launch rails to make sure they were safely away from the carrier aircraft when the rocket motor fired and the seeker head was activated. In addition to the four underfuselage hardpoints, two pylons were provided under the wings; these could carry four short-range AAMs on double launchers, two medium-range AAMs or two 2,500-litre (550 Imp gal) drop tanks. A team led by Yu. I. Levkin within the Mikoyan OKB's Section 209 (which was responsible for the armament) developed the ventral pantographic carriers/launch rails for the K-33 AAMs, the drop tanks' attachments and jettison system, and the passive ECM/IRCM chaff/flare dispensers.

The side-by-side seating arrangement envisaged initially soon gave place to a tandem arrangement with a narrower canopy featuring individual aft-hinged portions for the two cockpits. Due to the strong kinetic heating of the aircraft at high speeds a special kind of Plexiglas (type SO-200) was developed and subsequently produced for the Ye-155MP; it was capable of withstanding unilateral heating up to +220°C (+428°F) for a brief period.

Like all contemporary Mikoyan aircraft (and other contemporary Soviet tactical aircraft, for that matter), the Ye-155MP was to be equipped with K-36D Srs 2 'zero-zero' ejection seats developed and produced by NPP *Zvez**da*** ('Star' Scientific & Production Enterprise) led by Guy I. Severin.

The mission avionics included a TKS-2 secure data link system for tactical information exchange (***telekod**ovaya sis**tem**a*), ***Pre**riya* (Prairie) and *Makho**vik*** (Flywheel) secure voice link equipment and a lightweight and compact ARK-19 automatic direction finder (*avtoma-**tich**eskiy **rah**dio**kom**pas*) replacing the bulky and heavy ARK-10 ADF used hitherto. For the first time on a Soviet fighter, the Ye-155MP featured an MN-61 *Al**maz*** (Diamond) automatic voice annunciator warning the crew of critical failures (fire etc.) and dangerous flight modes. Special built-in guidance system and communications antennas, unique to the Ye-155MP and optimised for its airframe design, were developed; in order to reduce the number of aerials it was intended to install the *Po**tok*** (Stream) antenna-feeder system catering for the radio navigation, intra-group co-ordinate determination and data link systems. This work proceeded with the active involvement of Mikoyan OKB engineers I. M. Soob-botin, V. I. Yelmanov, N. S. Bychkov, K. N. Kolyada, N. F. Sedova, A. S. Zhirnov and Ye. G. Semyonova.

To ensure stable engine operation and optimise the fuel flow the engine control system was designed to include the RED-3048 digital control unit. It was effectively the first Soviet full authority digital engine control (FADEC) system; it ensured more precise fuel flow control than the traditional hydromechanical fuel control units (FCUs), with due regard to such variables as altitude, Mach number, kinetic heating of the airframe, engine rpm and engine air pressure. The APD-48 automatic engine starting control panel was developed specially for the D30F-6 turbofan; so was the SKP-48 engine monitoring system (*sis**tem**a kon**tro**lya za pa**rah**metrami*) which indicated current and maximum permissible values for engine rpm and turbine temperature.

The BSP-48 surge prevention system automatically throttled back the affected engine in the event of surge; it also automatically activated the igniters and the oxygen supply if the engine ran roughly or flamed out. The system was activated in all flight modes by the engine surge sensor and by the missile launch commands given by the crew.

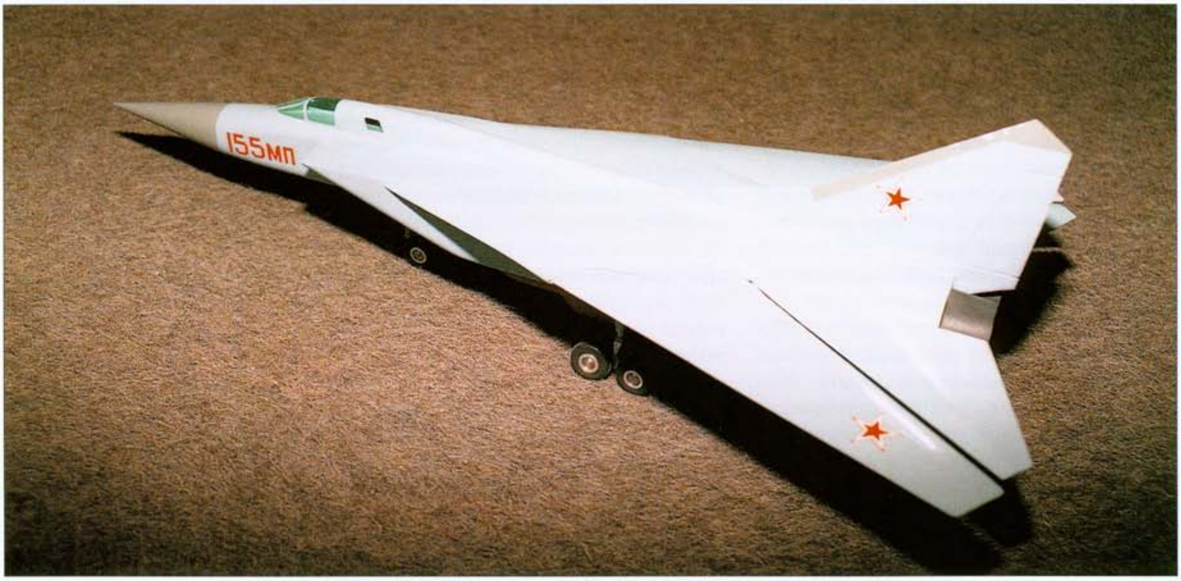
A special test equipment suite designated SOK-UBD (*sis**tem**a obyek**tiv**novo kon**tro**lya oo**cheb**no-boye**vykh** **dey**stviy* – combat training objective assessment system) was developed for checking the operation of the Zaslon WCS during the MiG-31's flight tests and in service. The Mikoyan OKB participated actively in its development.

Research into the acoustic loads acting on the thin-skinned structural elements of the wings and air intake assemblies, as well as into the effect of these loads on the airframe's fatigue life, became an important line of work. The Mikoyan OKB's structural strength department had to spend a lot of effort to obtain the required service life from the thin steel panels of the air intake structure. Airframe vibrations with frequencies of several hundred hertz caused fatigue cracking of the welded joints; it took a lot of research on ground rigs and flying testbeds to make sure that the subsequent operation of production MiG-31s would be safe. Mikoyan OKB engineers Yu. V. Moolyukin, V. N. Bookin and I. N. Skazko made a major contribution to this research.

Meeting an order from the Mikoyan OKB, the Kiev-based Looch (Ray, or Beam of light) design bureau developed the RIU display/recording device (*reghi**stree**ruyu-shcheye indi**tsee**ruyushcheye oo**stroy**stvo*) for the Ye-155MP. This device simultaneously recorded the indicated parameters in text format on heat-sensitive film, obviating the need for special deciphering equipment.

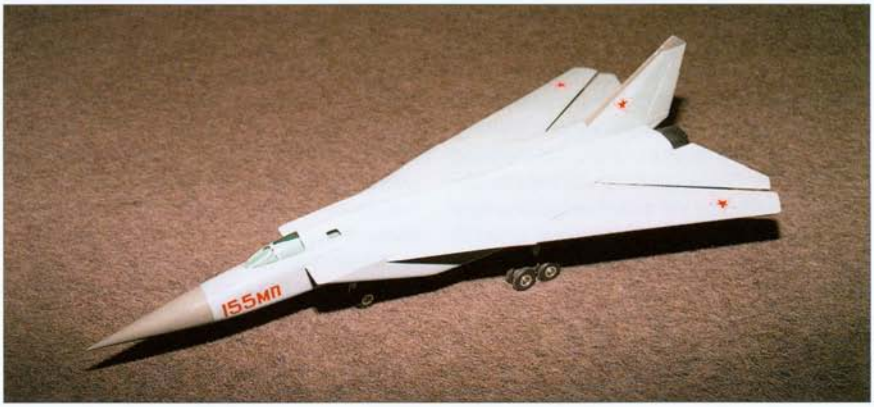
Thus by the mid-1970s the multitude of aircraft, electronics and defence industry enterprises involved in the S-155 programme had completed the entire scope of research and development work on the aircraft and its systems. In its ideology and performance the S-155 aerial intercept system, comprising the Ye-155MP heavy interceptor, the Zaslon WCS and the K-33 AAM, had no direct counterpart in the outside world and excelled contemporary Western aircraft.

The main versions which existed at the PD stage are described in brief below; some of them progressed as far as the advanced development project (ADP) and full-scale development stages.



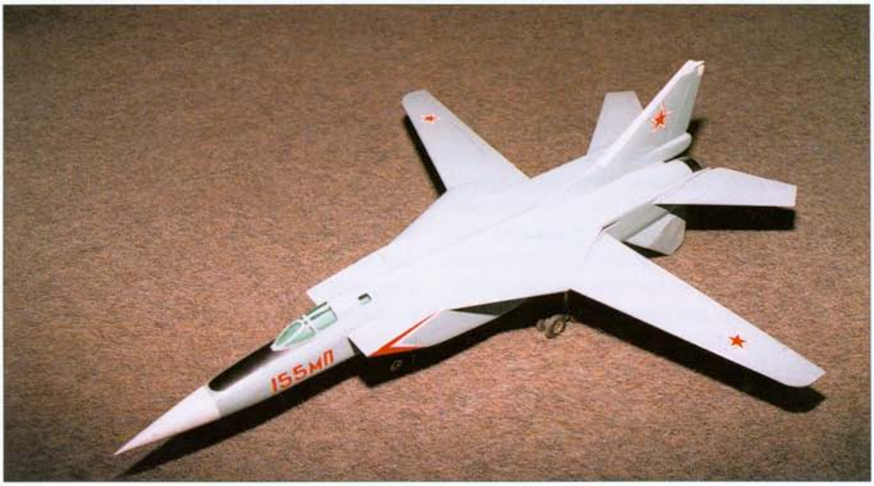
Yefim Gordon

▲ This desktop model shows an early project configuration of the Ye-155MP. The aircraft represents a radical departure from its MiG-25 ancestor, featuring variable-sweep wings and a single fin and rudder (both obviously patterned on the MiG-23 tactical fighter). Note also the four-wheel main gear bogies.



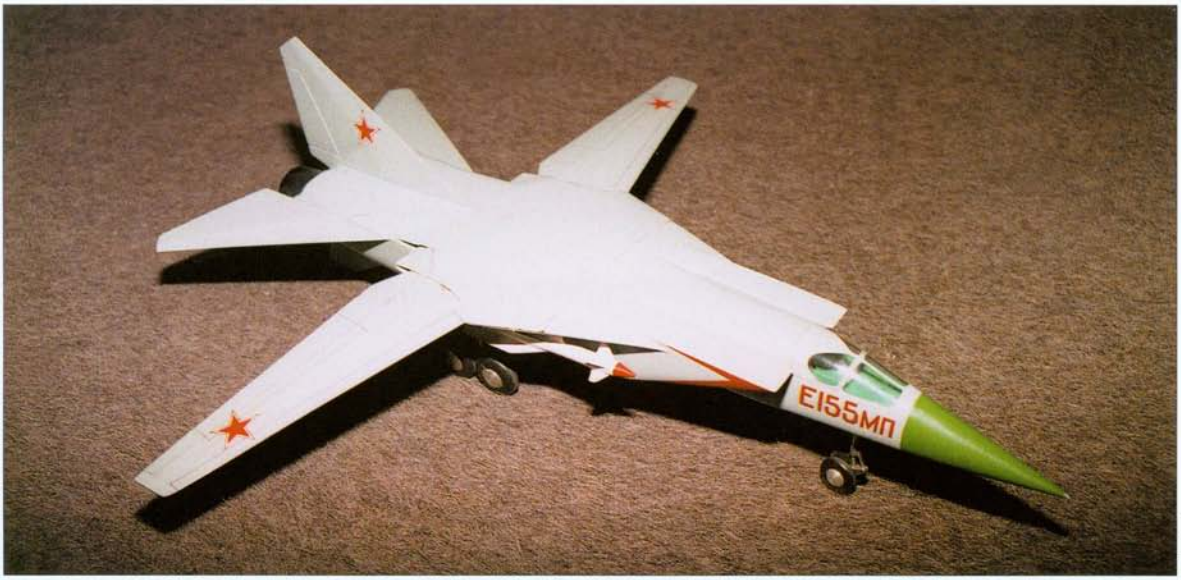
Yefim Gordon

► The Ye-155MP model with the wings at maximum sweep.



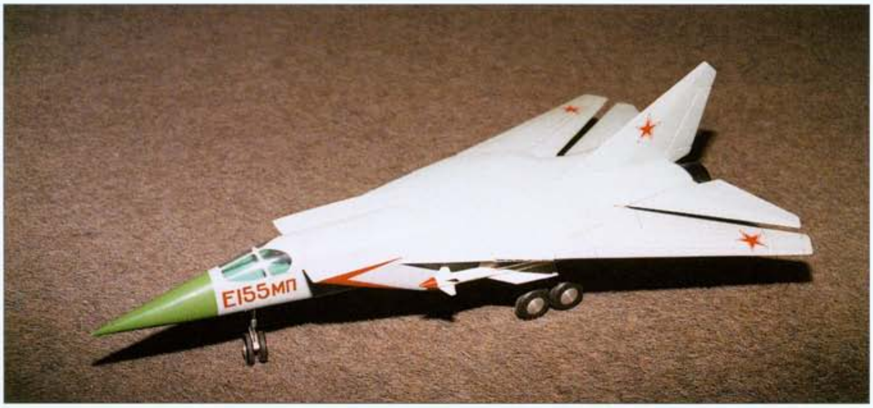
Yefim Gordon

► A different model of the same basic project in take-off/landing configuration with the wings at minimum sweep. Note the folding ventral fin (shown unfolded for clarity) and the addition of a brake parachute housing at the base of the fin. The colour scheme is also slightly different.



Yefim Gordon

▲
A different early project configuration of the Ye-155MP. At a first glance it differs from the models on the opposite page only in having side-by-side seating for the two crew instead of tandem cockpits and twin-wheel main gear bogies.



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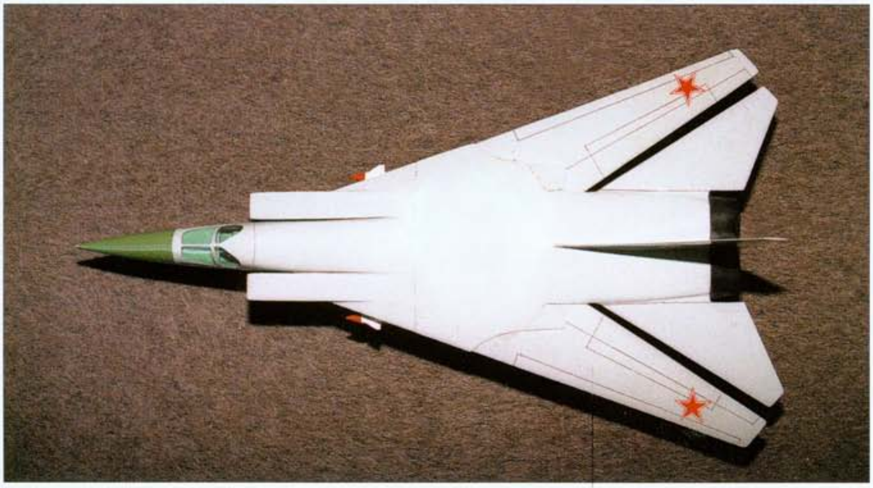
◄
The 'side-by-side' model with the wings at maximum sweep. Note the K-100 AAMs.



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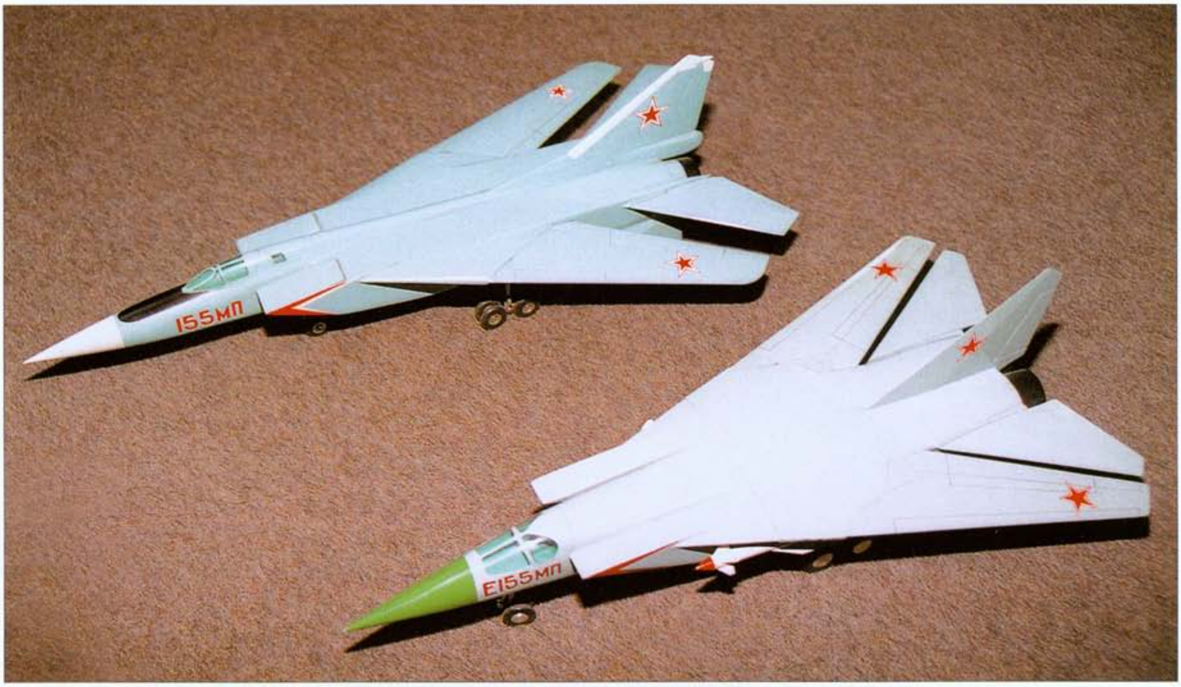
◄
This upper view of the same model emphasises the large area of the all-movable tailplanes.



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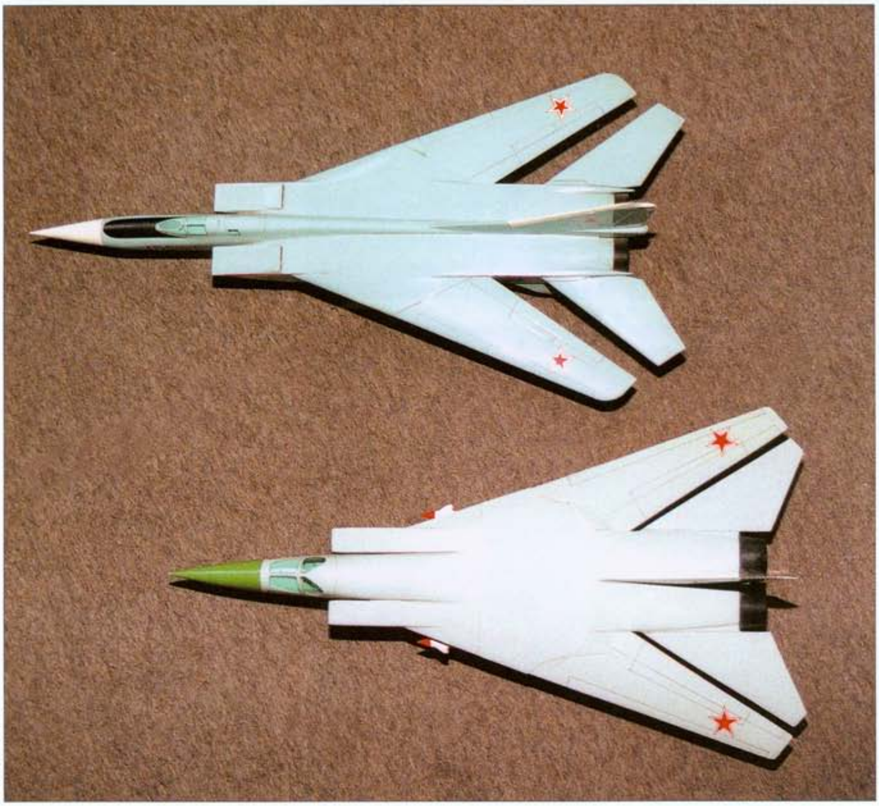

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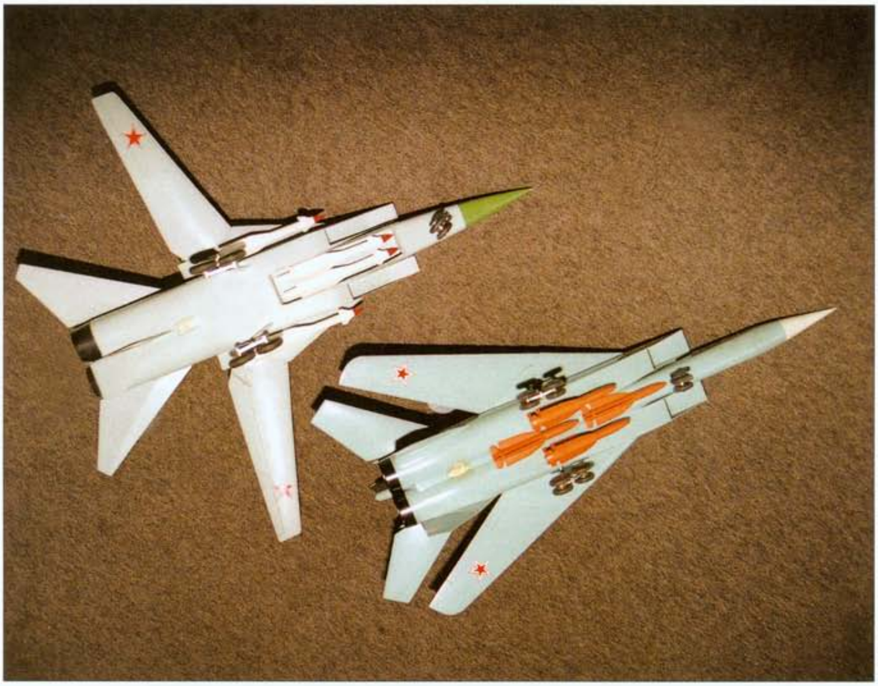
▲
An interesting comparison of the two preliminary design configurations. When the models are shown together it is immediately apparent that there's more to it than just cockpits. The tandem-cockpit version has a very much shorter landing gear wheelbase due to the forward-retracting nose unit. Note also the different shape of the vertical tail and the air intakes.

◄
This upper view shows clearly the difference in wing and tailplane shape and aspect ratio and the wings' placement relative to the horizontal tail.

►
These lower views of the side-by-side (left) and tandem-seat versions show the difference in the placement of the weapons (K-100 and K-33 missiles respectively). Note that the side-by-side version's air intakes, while being of necessity narrower, have a longer aperture to ensure the required mass flow. Another difference is that the side-by-side version has a single ventral fin folding to port to provide adequate ground clearance during take-off and landing, while the tandem-seat version has twin inward-folding ventral fins (shown here in fully deployed position, as they would be with the landing gear retracted).



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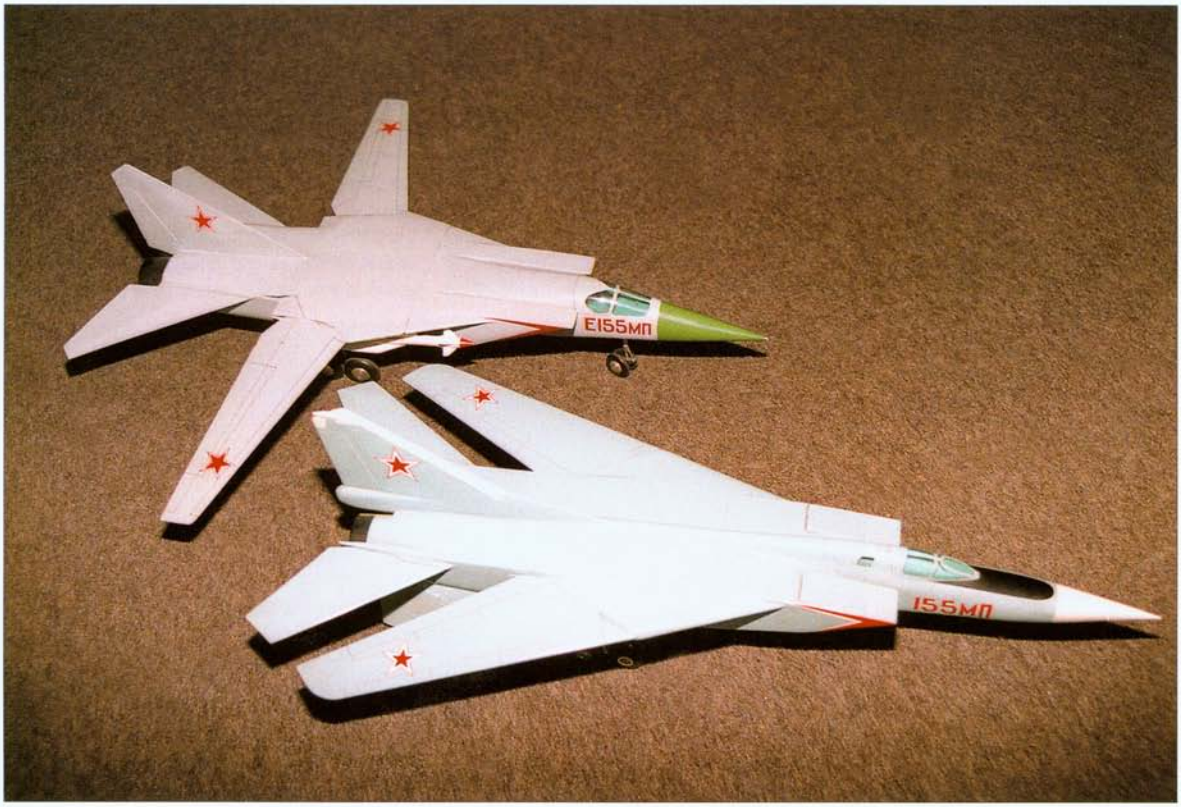
Another comparative view of the two variable-geometry ADP versions of the Ye-155MP.
▼



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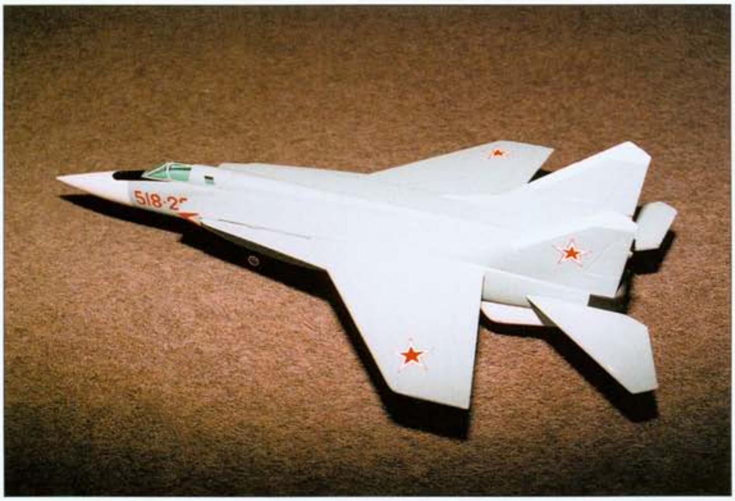

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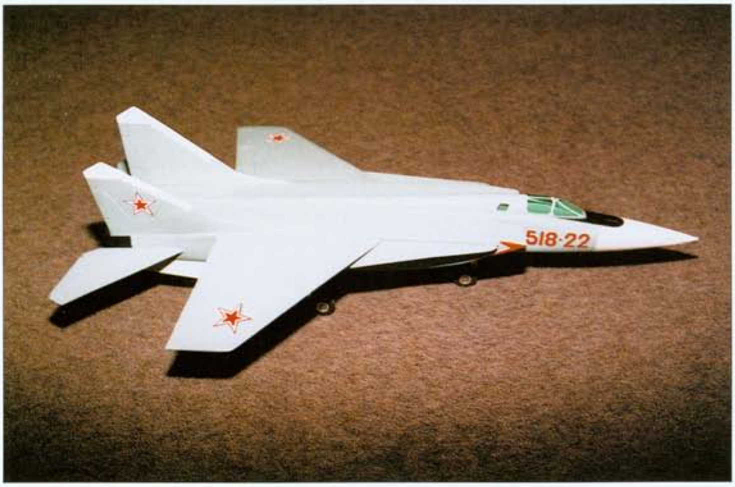


Yefim Gordon

Ye-155MP Interceptor Project (Variable-Geometry Wing Version)

One of the early Ye-155MP design studies was a cross between the MiG-23 and the MiG-25. The air intakes with horizontal airflow control ramps were similar to the MiG-25's but more aerodynamically refined. The crew of two was seated in tandem cockpits under a common canopy strongly reminiscent of the McDonnell Douglas F-4 Phantom II.

The shoulder-mounted variable-geometry wings and the tail unit featuring a single fin/rudder assembly and a prominent fillet were quite similar to those of the MiG-23. To ensure adequate directional stability, two large ventral fins were provided; they folded when the landing gear was extended, again in similar manner to the MiG-23.

The aircraft had a tricycle landing gear but the main units were unusual in having four-wheel bogies with small wheels to reduce runway loading, enabling operations from dirt or ice strips. The nose unit had twin wheels.

The aircraft was powered by two Solov'yov D30F afterburning turbofans. The armament consisted of three or four K-33 long-range air-to-air missiles semi-recessed in the lower fuselage. Additional short-range missiles could be carried on pylons under the fixed wing gloves.

The variable-geometry wings not only improved field performance but increased on-station loiter time in certain flight modes. However, the sweep change mechanism increased empty weight and structural complexity; besides, unlike the MiG-23, the aircraft was not intended for dogfighting where 'swing wings' might confer an advantage. Hence development of this version was soon abandoned.

▲▲

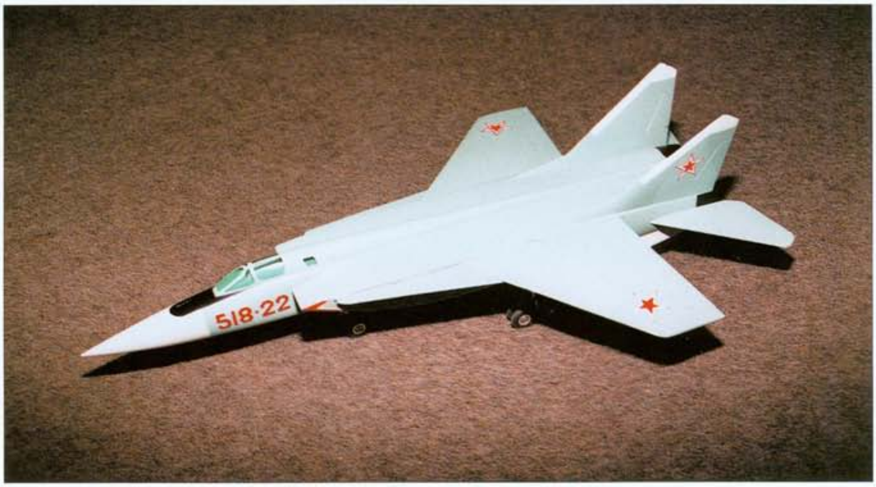
The *izdeliye* 518 preliminary design project represented a break from the VG projects, reverting to twin tails and fixed-sweep wings.

▲

Numerous versions of *izdeliye* 518 were developed. The '518-22' shown here has large downward-folding (!) leading-edge root extensions deployed for low-speed flight only.

►

Apart from the LERXes, the '518-22' was remarkably similar to the eventual MiG-25MP prototype.



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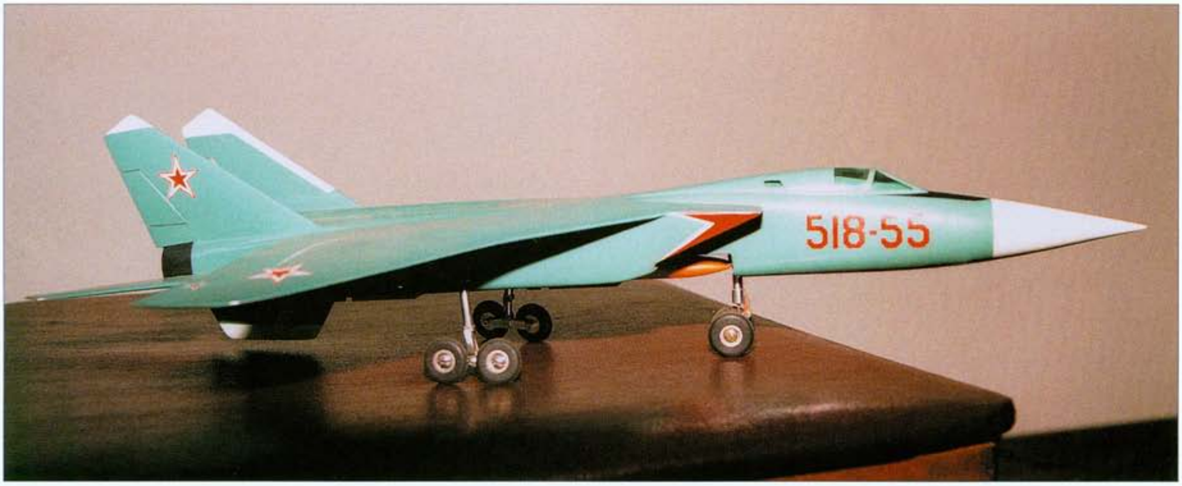


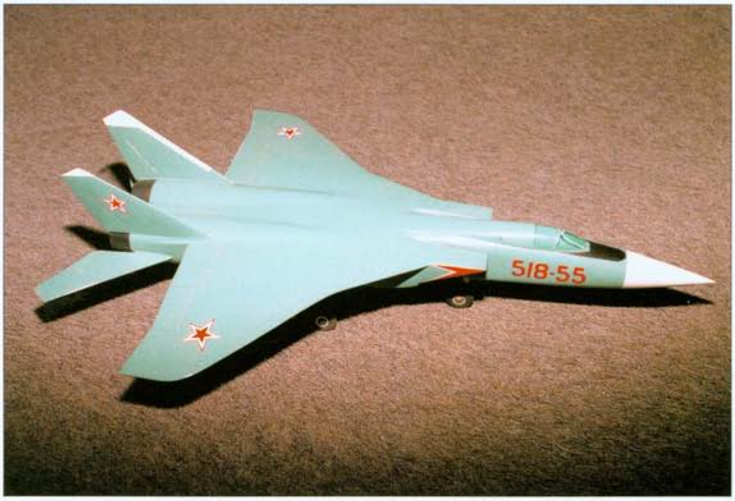
Yefim Gordon

Ye-158 Interceptor Project

This PD project envisaged a twin-engined two-seater tailless delta with ogival wings. It never materialised.

Ye-155MP (*Izdeliye* 518-21) Interceptor Project

A new project version bearing the in-house designation *izdeliye* 518-21 was proposed in 1968. In keeping with Communist Party Central Committee/Council of Ministers directive No.397-152 issued on 24th May 1968 the aircraft was to commence joint state acceptance trials in the fourth quarter of 1971. However, further research showed that *izdeliye* 518-21 would be overweight and short on rate of climb and service ceiling; hence the development of this version was discontinued and a redesign ensued.



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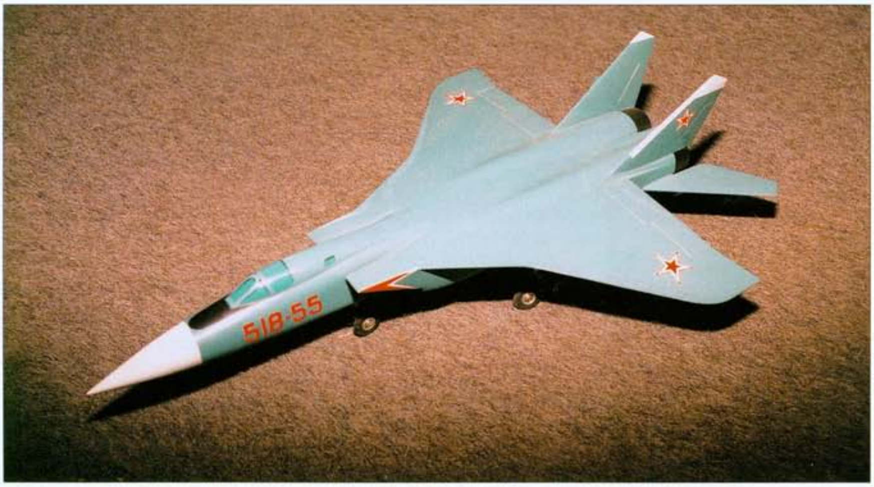
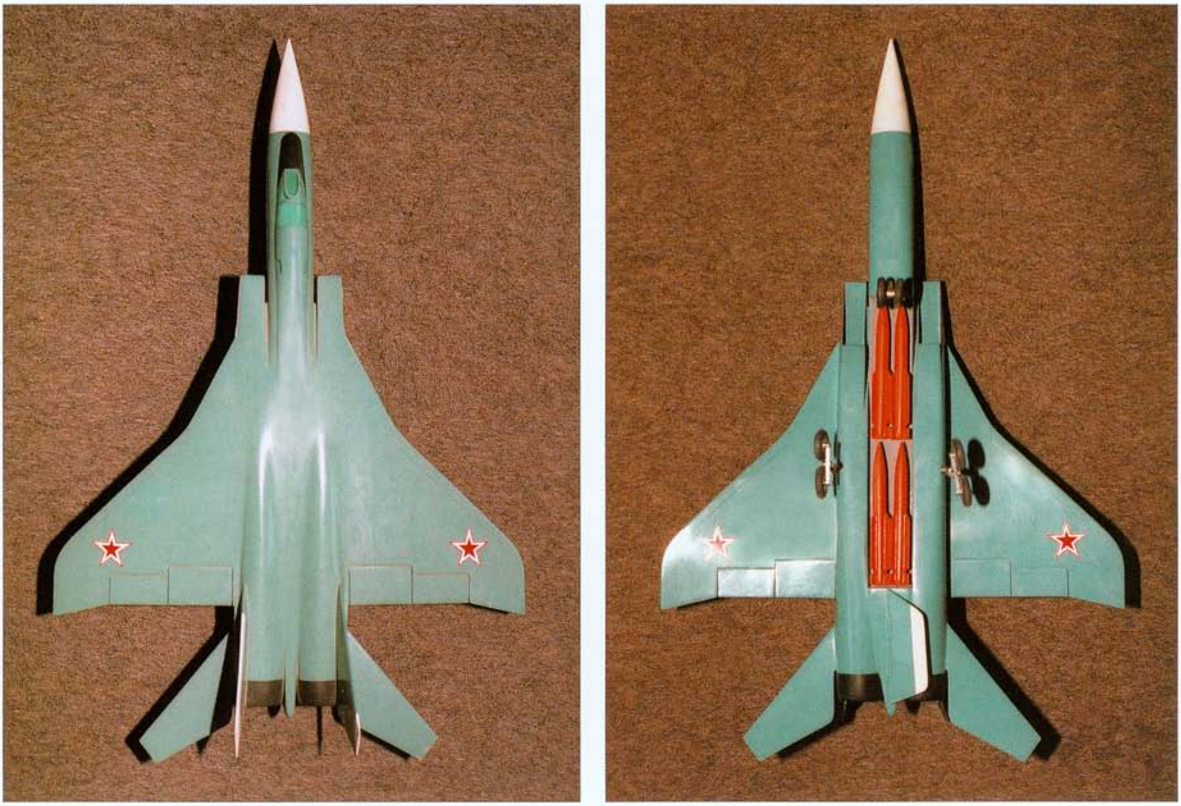


Yefim Gordon

▲▲
Another project configuration, the '518-55', had an open weapons bay. Curiously, the cockpit appears to provide plenty of room for the pilot but no room at all for the weapons systems operator's head.

▲
This view shows that the '518-22' had a rather different wing planform (quite similar to that of the MiG-29 fighter, in fact) and a totally different fuselage.

◄
Another aspect of the '518-55'; the short wheelbase is noteworthy.



Yefim Gordon (both)

▲▲ **These two views clearly illustrate the wing planform and the weapons bay of the '518-55' with side-by-side placement of the K-33 missiles; the latter represent the definitive version with short strake-like fins and folding rudders. Note also that the ventral fin (shown deployed on page 23) is folded here for take-off and landing.**

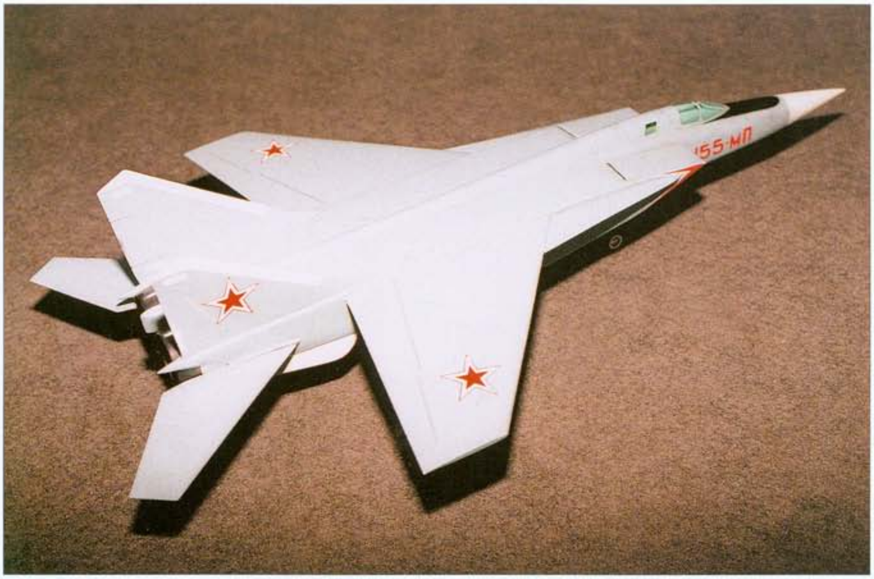
Ye-155MP (*Izdeliye* 518-22) Interceptor Project

Work on a version of the Ye-155MP project designated *izdeliye* 518-22 commenced in 1969. Two years later the choice of fixed-geometry trapezoidal wings, tandem seating for the crew and semi-recessed carriage of the K-33 missiles had been finalised. Unlike the MiG-25, however, the *izdeliye* 518-22 featured prominent leading-edge root extensions (LERXes) and leading-edge flaps. The powerplant consisted of two D30F-6 afterburning turbofans which were much more fuel-efficient than the MiG-25's R15B-300s, especially in subsonic flight. These features were later incorporated in the Ye-155MP advanced development project known as *izdeliye* 83 – the aircraft which eventually reached the hardware stage.

In the course of detail design the Ye-155MP turned into a totally different aircraft whose similarity to the MiG-25P was limited to the general arrangement and overall dimensions. In its *izdeliye* 518-22 (later *izdeliye* 83) form the Ye-155MP differed from the MiG-25P in the following ways (apart from the powerplant, armament and WCS):

- the wings were equipped with LERXes and leading-edge flaps;
- the wings now had a three-spar structure instead of the MiG-25's two-spar structure for added stiffness and the air intake trunks were also stiffened, increasing the maximum indicated airspeed at low altitude;
- the landing gear was totally reworked, the forward-retracting main units featuring twin-wheel bogies with smaller wheels to cater for the higher all-up weight. The wheels on each bogie were located in a staggered-tandem arrangement, the forward wheel being located inboard and the rear wheel outboard; during retraction the bogie rotated nose-up around the oleo to lie inverted. The twin-wheel nose unit retracted aft, not forward. The forward mainwheel well doors were forward-hinged, doubling as airbrakes;
- the internal fuel capacity was increased and provisions were made for large underwing drop tanks.

But, of course, the 'cherry on the cake' was the interceptor's Zaslon WCS and the K-33 long-range AAMs which, for the first time in the Soviet Union, were carried in a semi-recessed



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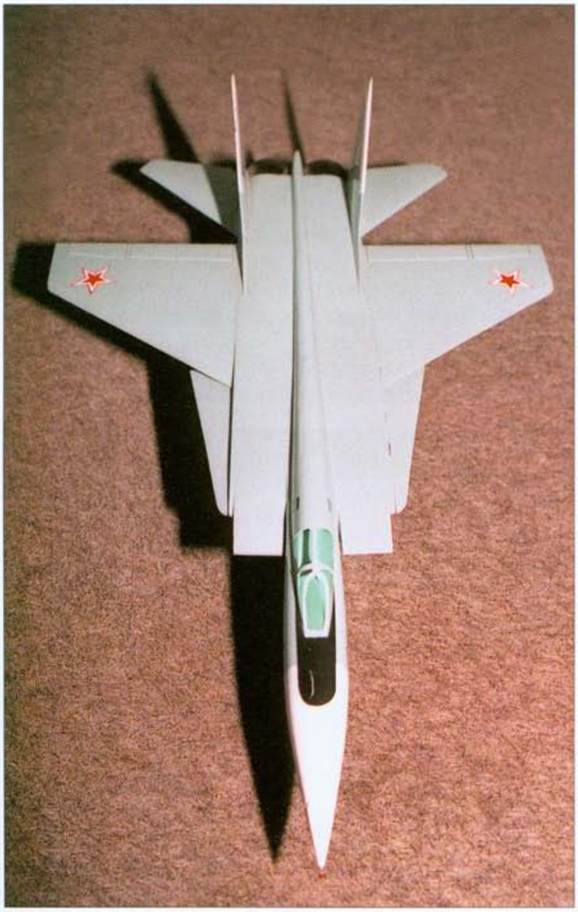
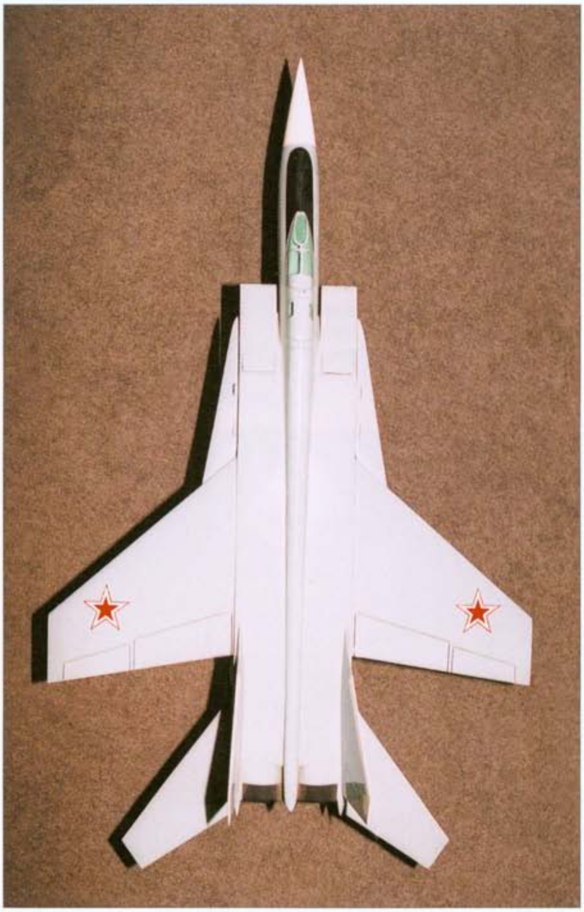
◄
This display model, again marked '155MP', is just one step away from the Ye-155MP's final project configuration. The folding LERXes of the '518-22' are still there but the rear fuselage has been revised; note the small conical fairings at the base of the fins (probably housing electronic countermeasures equipment).

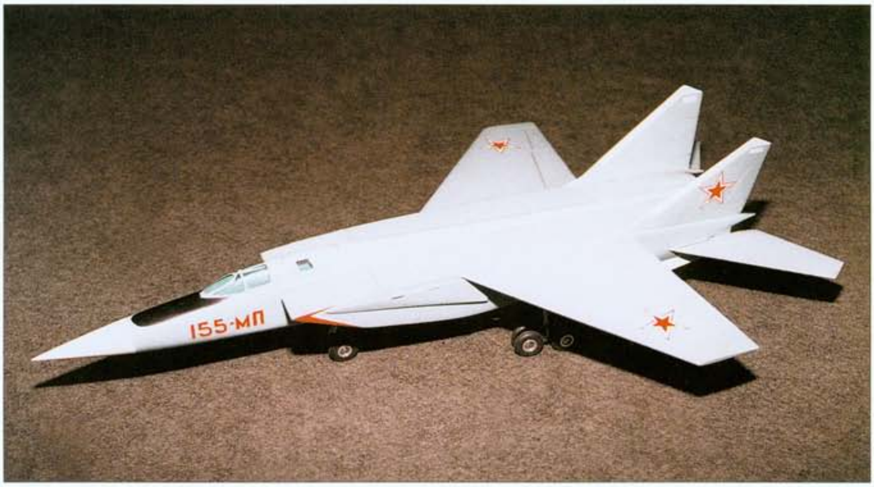
These two views of the same model show the wing planform with the LERXes deployed for take-off and landing/low-speed flight and the outward-canted fins. Note the conical radome whose shape was yet to change.
▼ ▼





Yefim Gordon (both)

The model of the penultimate Ye-155MP project with the wings in cruise configuration with the LERXes folded to lie flat against the sides of the air intake trunks.



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arrangement. A GSh-6-23 cannon was installed on the starboard side of the fuselage.

The mission avionics included a retractable IRST pod under the nose, an INS with floating gyros and SHORAN/LORAN systems having their own digital computer. An APD-518 data link system (*appara***too***ra pere***da***chi* **dahn***nykh*) was provided, allowing the aircraft to exchange target data with ground command posts, other interceptors and airborne early warning and control (AEW&C) aircraft.

Ye-155MP (*Izdeliye* 518-31) Interceptor Project

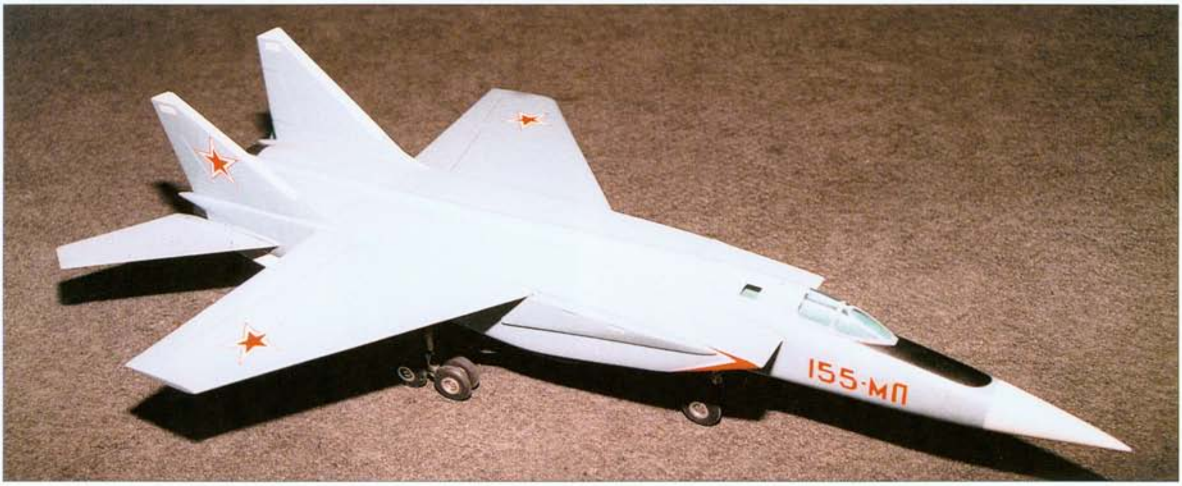
This was another twin engined two-seat interceptor project. Regrettably no further information is available on how this aircraft looked or its design details.

Ye-155MP (*Izdeliye* 518-55) Interceptor Project

The general arrangement group of the Mikoyan OKB s preliminary design (PD) section considered this version of the Ye-155MP under the project code *izdelye* 518-55. The aircraft was a cross between the MiG-25 and the eventual MiG-31, combining the forward and centre fuselage of the latter with the tail unit of the former, except that the wings were more like those of the MiG-29 fighter

Four K-33 air-to-air missiles were carried semi-recessed in the fuselage; the main landing gear units had twin-wheel bogies with the wheels placed in line, as on the Swedish SAAB JA37 Viggen The trapezoidal wings had large LERXes and a kinked trailing edge This arrangement was fairly close to what the MiG-31 eventually looked like.

Another view with the LERXes folded. Note the revised canopy providing more headroom for the WSO and the four-wheel main gear bogies – another feature that would change before the Ye-155MP materialised.



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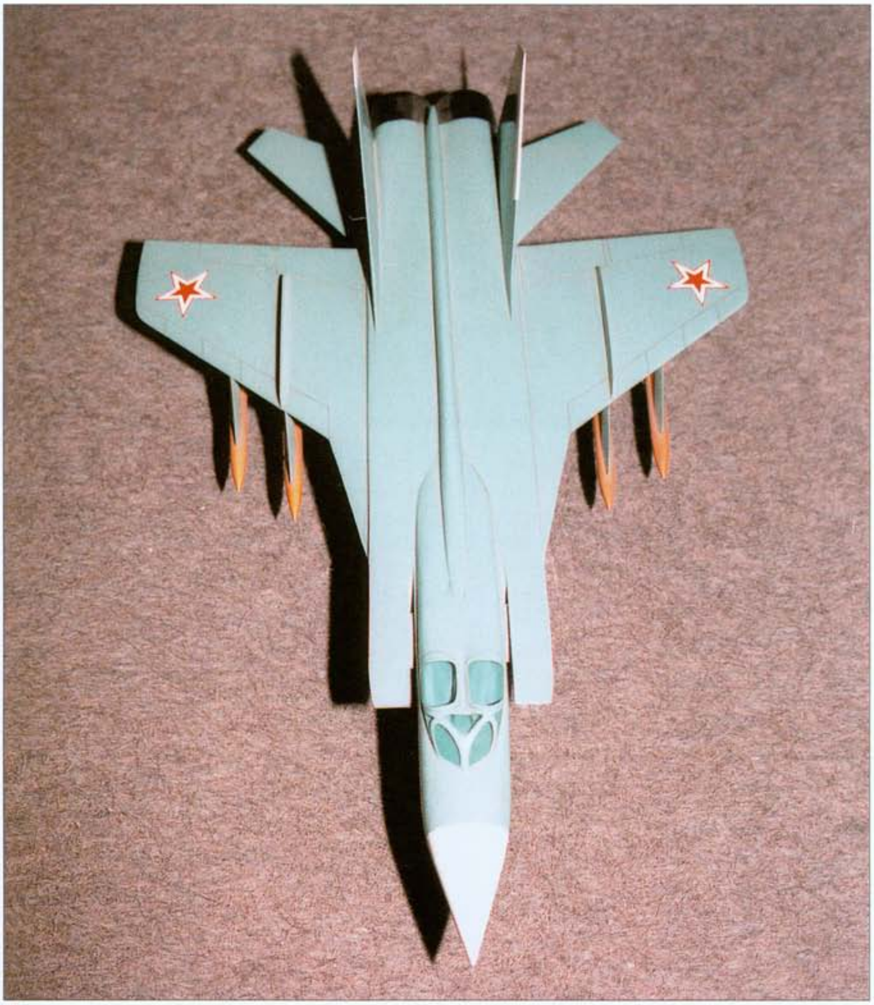

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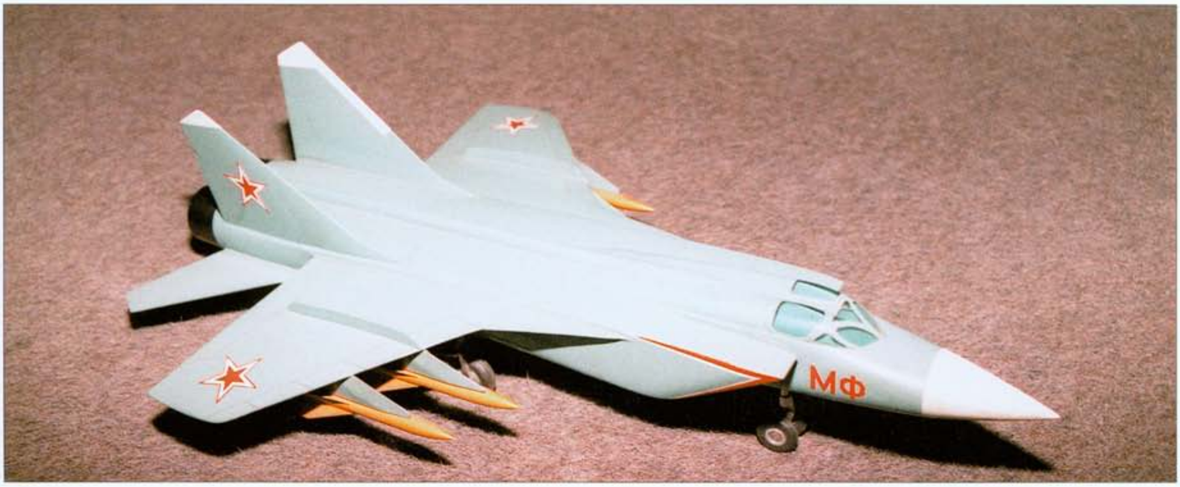
◄
Apart from the basic interceptor version, the Ye-155M was to have a tactical strike version designated Ye-155MF (*frontovoy*). The aircraft featured a radically redesigned forward fuselage with side-by-side seating and a short conical radome. The shape of the wings, featuring small fixed LERXes, matches that of the actual MiG-31. Four Kh-58 air-to-surface missiles are suspended on the wing pylons.

A three-quarters front view of the Ye-155MF. The shape of the cockpit canopy resembles that of the Grumman A-6 Intruder.
▼



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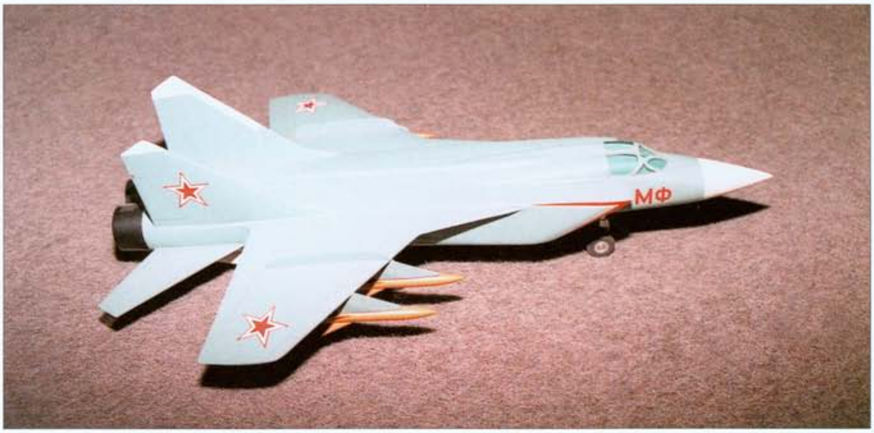
A side view of the Ye-155MF, showing the long nozzles of the D30F-6 engines as fitted to the actual MiG-31.



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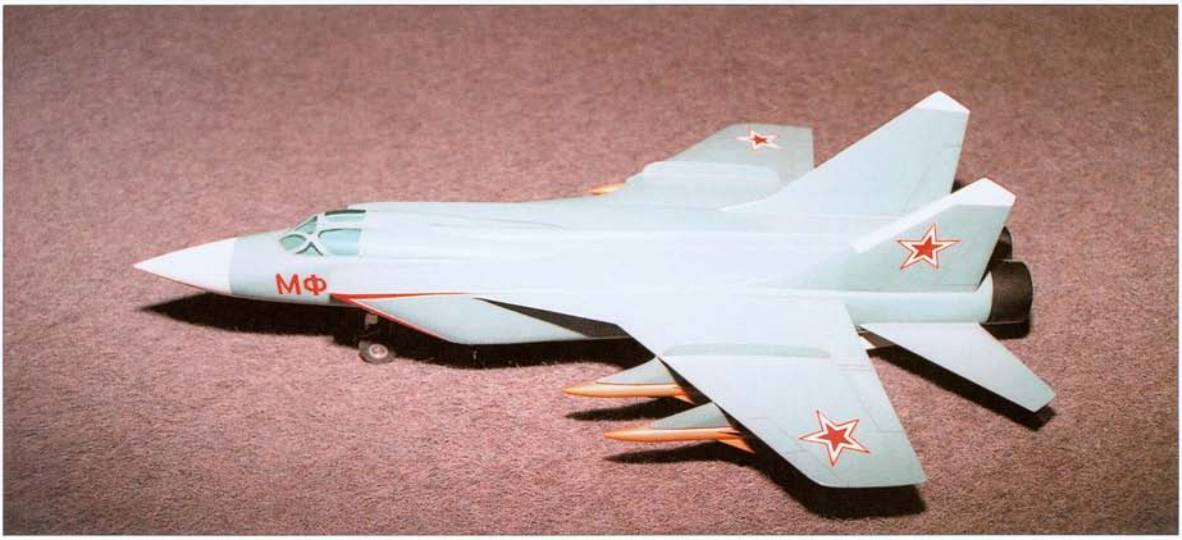
Ye-155MF Tactical Bomber Project

As the Mikoyan OKB's general arrangement section started work on the drawings of the Ye-155MP interceptor (the future *izdeliye* 83) in the early 1970s, someone suggested dusting off the 1960s idea of developing the MiG-25 into a tactical bomber. Designated Ye-155MF (*fronto***voy** – frontline, ie tactical), the aircraft was capable of penetrating enemy air defences at high supersonic speed, neutralising air defence radars and hitting high-priority targets with bombs and air-to-ground missiles from high altitude

The Ye-155MF was quite similar to the eventual MiG-31, except for the wider forward fuselage with the two crew members seated side-by-side under a large canopy with individually hinged portions in similar manner to the Sukhoi Su-24 tactical bomber to give the navigator/WSO a better field of view. The landing gear was also similar to the MiG-31's, featuring a twin-wheel nose unit and twin-wheel main gear bogies with a staggered-tandem wheel arrangement. The armament was carried on four wing hardpoints – typically four Kh-58 (ASCC AS-11 *Kilter*) anti-radiation missiles – and in fuselage bays which could house up to twelve 250-kg (550-lb) bombs.

However, the Ye-155MF lost out to a more attractive proposal put forward by the Sukhoi OKB – the swing-wing T-6 tactical bomber (as the Su-24 was known in-house), and the project was shelved. Only much later did a strike version of the *Foxhound* materialise in the form of the MiG-31F/MiG-31FE projects and the MiG-31BM multi-role aircraft developed in the 1990s (see next chapter).

Another view of the same model. The Ye-155MF would have been a real scary monster, looking definitely nose-heavy. Generally such models tend to show little regard for accuracy, but the large nosewheels visible here suggest a reinforced nose gear unit was envisaged.



Yefim Gordon

PART TWO

THE KENNEL

Foxhound Versions

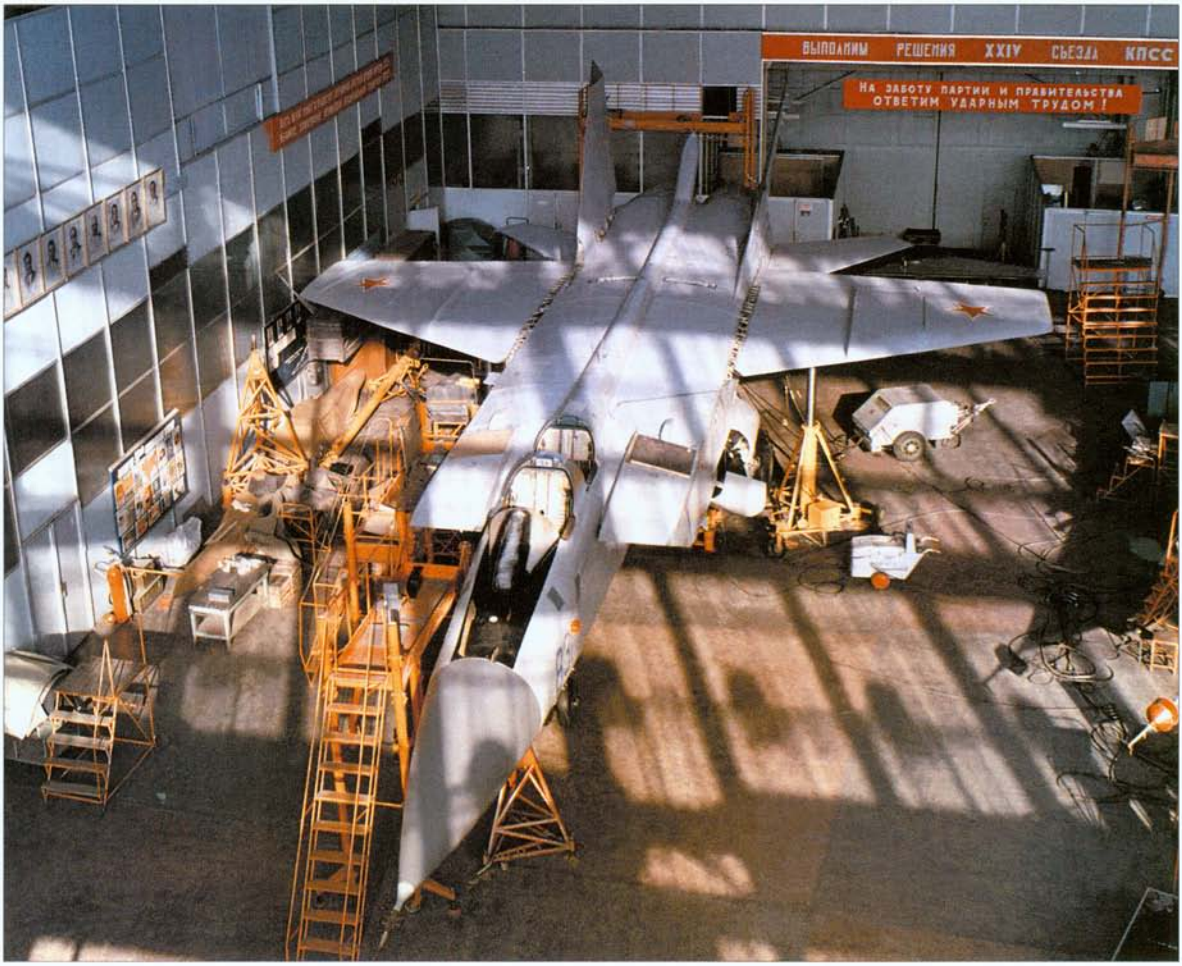
Ye-155MP Interceptor Prototypes (*Izdeliye* 83)

In 1972 the Mikoyan OKB embarked on the development of a radically different version of the MiG-25P/PD interceptor – the Ye-155MP (to be designated MiG-25MP in service). A lot of alternative layouts came into consideration. Once the optimum one had been chosen, work got under way on the detail drawings; at this stage the new interceptor received a separate in-house product code, *izdeliye* 83 – which, interestingly, was lower than the MiG-25P's (*izdeliye* 84). Despite the lower top speed and service ceiling as compared to the MiG-25P/PD, the new aircraft could meet the higher demands for an advanced interceptor posed by the PVO more fully.

The Ye-155MP was designed around two Solov'yov D-30F afterburning turbofans. As already mentioned, the D-30F was a considerably reworked derivative of the D-30 commercial turbofan developed by the Perm'-based OKB-19 in 1963 for the Tu-134 short-haul airliner. This was not a simple addition of an afterburner and an axisymmetrical convergent/divergent nozzle to the basic D-30 Srs I; the D-30F incorporated a multitude of design changes and improvements. Development of the new engine began in 1972, almost concurrently with the aircraft it was to power.

The D-30F was characterised by a high turbine temperature and a high overall engine pressure ratio (EPR) which assured high fuel efficiency in supersonic mode at both high and low altitude. The D-30F was put through its paces on the two *izdeliye* 99 engine testbeds – modified MiG-25s coded '991 Blue' (*izdeliye* 99 No.1, c/n 990001) and '992 Blue' (c/n 990002). Upon retirement the latter aircraft was dismantled, serving as a cutaway

The first prototype Ye-155MP, *izdeliye* 83/1 (appropriately coded '831 Blue'), nearing completion at the Mikoyan OKB's prototype manufacturing facility in Moscow. As was customary at the time, the shop walls are bedecked in portraits of Communist Party Central Committee members and slogans exhorting the staff to work industriously. ▼


ВЫПОЛНИМ РЕШЕНИЯ XXIV СЪЕЗДА КПСС
НА ЗАБОТУ ПАРТИИ И ПРАВИТЕЛЬСТВА ОТВЕТИМ УДАРНЫМ ТРУДОМ !

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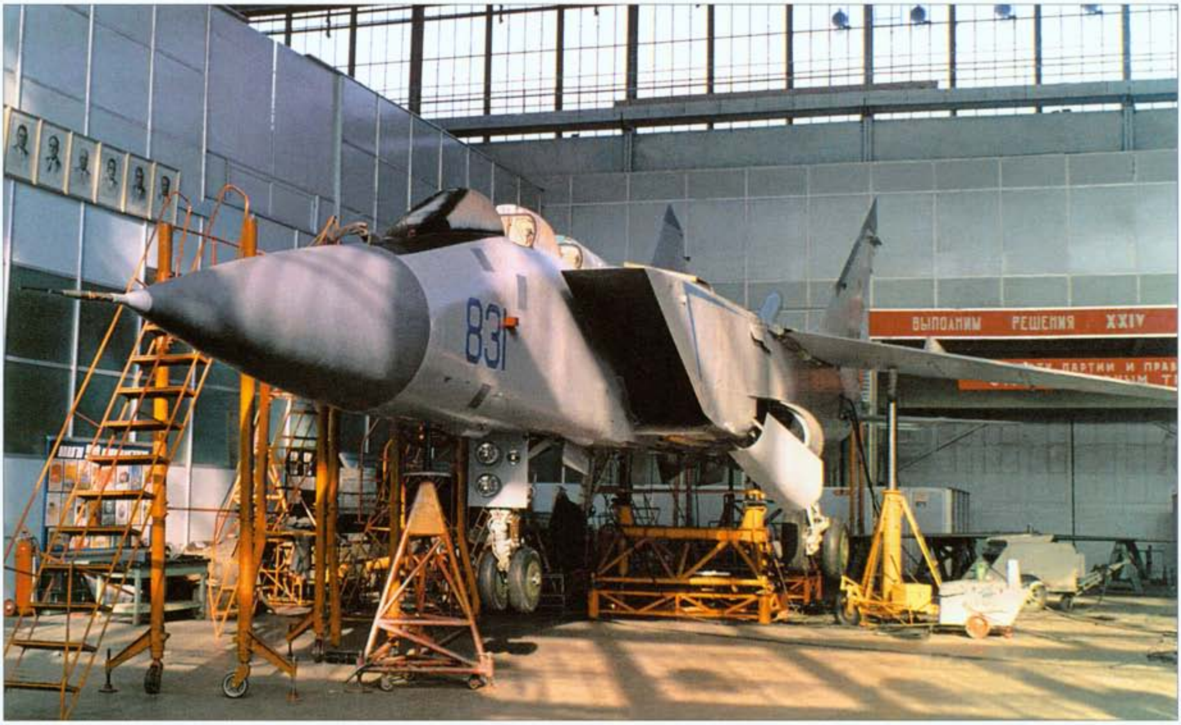


RSK MiG

▲
Another view of the *izdeliye* 83/1 in the assembly shop. The aircraft is jacked up for landing gear operation tests.

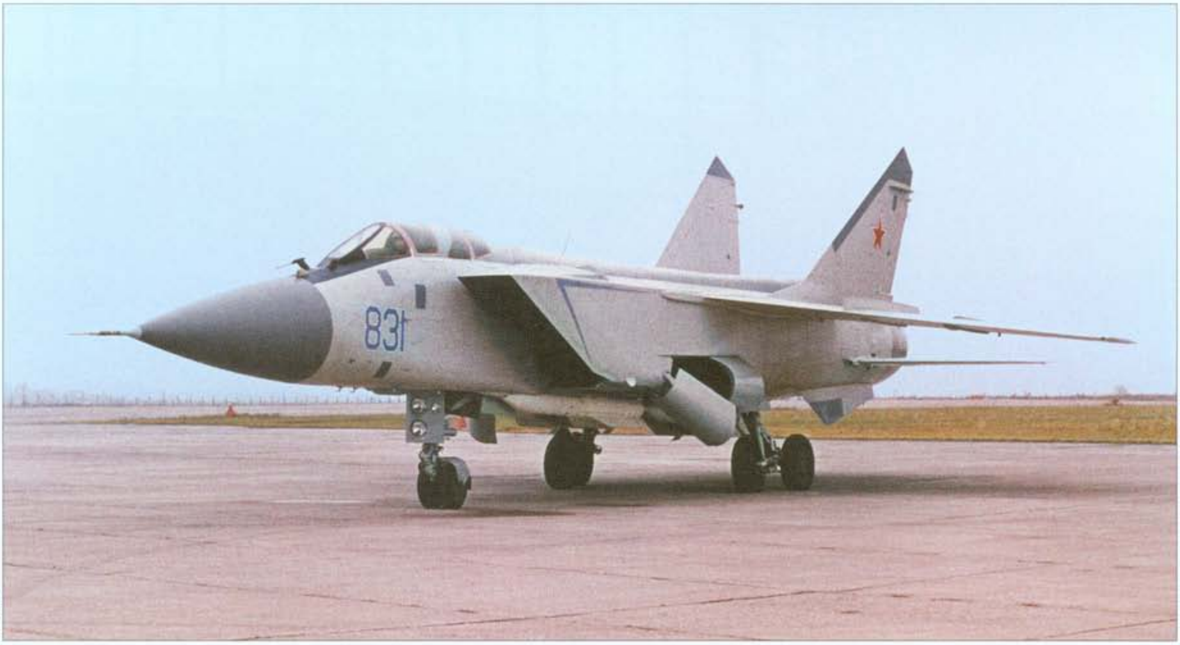
instructional airframe at the Moscow Aviation Institute to this day.

As described in the preceding chapter, the new interceptor was to feature an all-new armament system built around the Zaslon phased-array radar which was expected to outperform any existing fire control radar. The addition of a second crewmember (the weapons systems operator/navigator) not only facilitated the operation of the more complex weapons system but also eased the psychological strain on the pilot during long patrol missions, especially overwater flights – the pilot no longer felt he was 'all alone over the briny'. Besides, the provision of a telescopic control stick and a pop-up forward vision periscope in the rear cockpit obviated the need for a specialised trainer version.

The detail design stage lasted several years; the Mikoyan OKB's General Designer Rostislav Apollosovch Belyakov exercised overall control of the Ye-155MP programme. The result of these efforts was an aircraft with unmatched capabilities. Despite its apparent similarity to the MiG-25P/PD, the new aircraft was different in virtually every aspect, be it aerodynamics (which were more refined), structural design, powerplant, armament or avionics.

The Ye-155MP interceptor was a two-seat fourth-generation aircraft with enhanced operational capabilities as compared to the MiG-25. Its mission was to intercept high- and low-flying agile and non-agile targets (including those flying at ultra-low altitude) in head-on and pursuit mode while travelling at high supersonic speeds. The aircraft was to be capable of doing this around the clock, in fair or poor weather, regardless of the active or passive ECM the enemy might set up.

The fuselage and air intake trunks contributed a sizeable amount of lift; in some flight modes this share could reach 50%. The relatively thin swept wings were cambered and featured small LERXes. Being aware that the MiG-25's tests and operational service had revealed insufficient wing torsional stiffness, the designers reworked the Ye-155MP's wing structure, introducing a third spar. The aerodynamic camber delayed the onset of tip stall at high angles of attack in subsonic mode, improving lateral stability. The LERXes had a leading-edge sweep of 70° and served to enhance manoeuvrability at high AOAs. The wings featured four-section leading-edge flaps used for increasing lift in on-station loiter mode; the trailing edge was occupied by two-section flaps with a maximum setting of 30°



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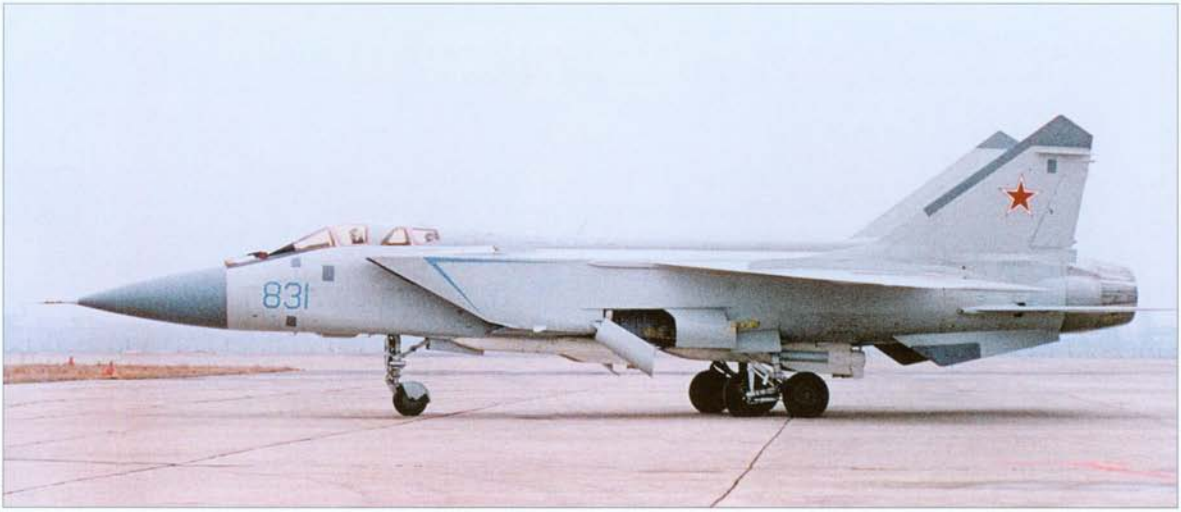
▲ **The first prototype Ye-155MP at Zhukovskiy during manufacturer's flight tests.**

Another view of '831 Blue', showing the dummy R-33 missiles semi-recessed in the belly (note that the rear pair is set lower than the forward one) and the nozzle petals of the D30F-6 engines. ▼

and ailerons with deflection limits of ±20°. To improve the lift/drag ratio in subsonic cruise a special configuration was used, the LE and TE flaps being set 13° and 5° respectively, the ailerons drooping 5° at the same time. Only the trailing-edge flaps were used (at full 30° deflection) for take-off and landing.

The tricycle landing gear featured a twin-wheel nose unit (which, unlike the MiG-25's, retracted aft, not forward) and forward-retracting main units with twin-wheel bogies. The latter utilised an unorthodox staggered-tandem arrangement, the front wheels being mounted inboard of the oleo and the rear wheels outboard (unlike, say, the SAAB JA/AJ 37 Viggen where the wheels were situated in line). This design allowed the bogies to somersault during retraction, tilting nose up to occupy the smallest possible space; another bonus was the dramatically reduced runway loading, which allowed the interceptor to operate from *ad hoc* dirt and snow/ice runways. The main-wheel wells were closed by tandem doors, the forward-hinged forward segments doubling



RSK MiG

as airbrakes. In supersonic flight the airbrakes could be used at high altitudes, but not at low altitudes due to dynamic pressure/structural strength limits.

Striving to achieve the maximum possible rate of climb, the Mikoyan OKB initially used the so-called 'knock-knock-come-on in' system for the Ye-155MP prototypes' main gear doors (that is, the forward door segments-cum-airbrakes opened only when the landing gear was in transit). Thus the designers tried to minimise the fighter's drag, thereby reducing the time required for take-off. Later, however, this feature was dropped, all wheel well doors remaining open when the gear was down.

The crew escape system made use of the proven Zvezda K-36DM zero-zero ejection seats. The K-36DM had a mechanically triggered ejection gun; the Mikoyan OKB said no to an electric firing mechanism because it was more prone to failures.

While developing the aircraft as such, its engines and radar, the designers had to overcome a host of technical problems and cut through miles of bureaucratic red tape. All of this caused prototype construction to be delayed. At a conference of the PVO's top command in 1975 it was pointed out that in spite of the 33 (!) government directives concerning the MiG-25MP issued to date, the aircraft still hadn't entered service.

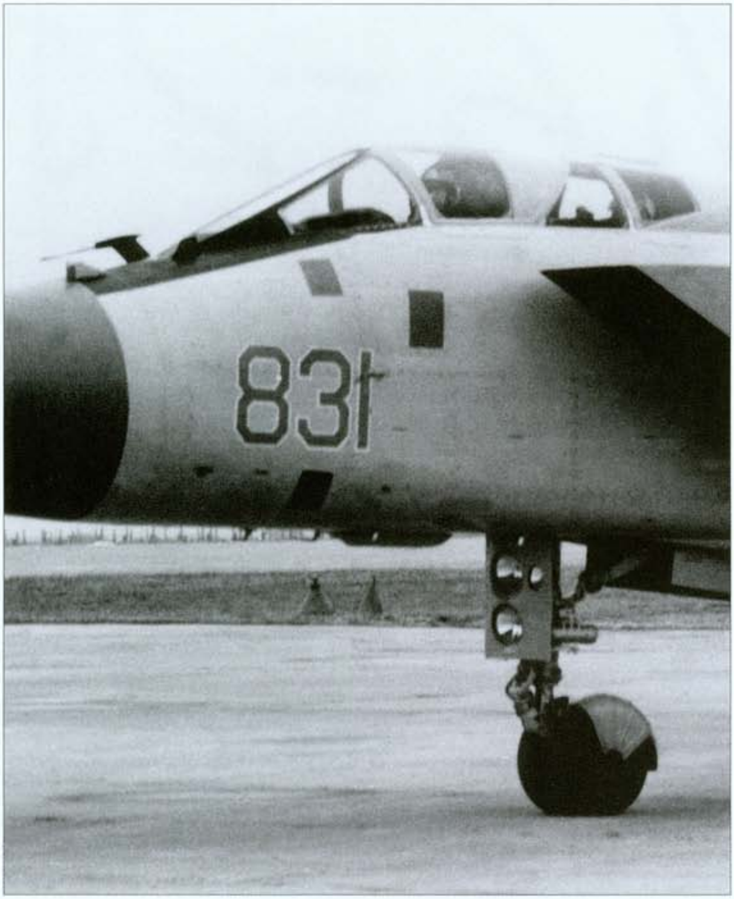
The two prototypes were built at the Mikoyan OKB's experimental production facility, MMZ No.155, in Moscow. Meanwhile, the manufacturing documents were progressively issued to the Gor'kiy aircraft factory No.21 for the purpose of building a low-rate initial production (LRIP) batch of MiG-25MPs to be used in the trials programme. Appropriately coded '831 Blue' (that is, *izdeliye* 83 No.1, or *izdeliye* 83/1, as it was known at the OKB), the first prototype was rolled out and ready for testing in mid-1975. It lacked the radar (which was substituted by test equipment), some other avionics items and the cannon. As originally built and flown the aircraft had stock MiG-25RB wing panels featuring a sharp leading edge with neither LE flaps nor LERXes. Later the prototype was rewinged, receiving the intended wings with leading-edge devices and drooping ailerons.

Unlike later production MiG-31s, the MiG-25MP's forward main gear doors/airbrakes were part of both the undersurface and the fuselage side, opening outwards and down at 40° to the aircraft's plane of symmetry. Instead of the envisaged Zvezda K-36DM ejection seats, both cockpits were equipped with KM-1M seats designed in-house. The forward sections of the air intakes were easily detachable for maintenance access to the equipment inside the fuselage.

In August 1975 the management of the Mikoyan OKB appointed the company's chief test pilot Aleksandr V. Fedotov, Hero of the Soviet Union, as the MiG-25MP's project test pilot and S. G. Polyakov as engineer in charge of the tests and V. N. Kichev as the aircraft's mechanic. On 16th September that year '831 Blue' made its successful first flight with

RSK MiG

▲
Mikoyan OKB chief test pilot Aleksandr V. Fedotov, seen here in his G-suit and full-face pressure helmet designed for high altitudes. He was the Ye-155MP's first project test pilot, making the 83/1's maiden flight on 16th September 1975.



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▲
The forward fuselage and nose gear unit of the '83/1'. This view shows well the interceptor's canopy design, the twin landing lights and the taxi light built into the forward nose gear door segment.

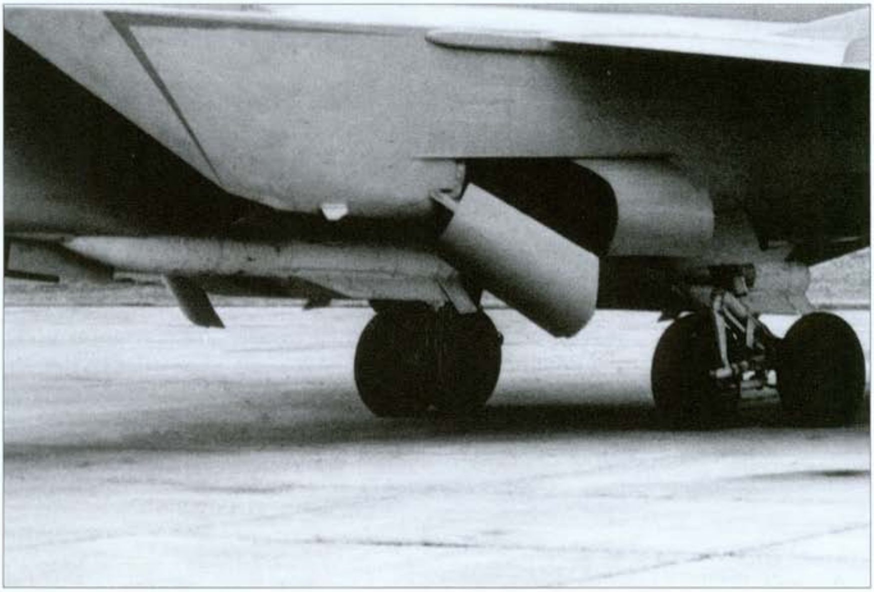
Fedotov at the controls and V. S. Zaitsev in the back seat; the manufacturer's flight test programme had begun.

One by one, Mikoyan OKB test pilots Pyotr M. Ostapenko, Boris A. Orlov, Aviard G. Fastovets, Valeriy Ye. Menitskiy and Toktar O. Aubakirov joined the flight test programme. The second prototype MiG-25MP, '832 Blue' (*izdeliye* 83/2), was completed with a full avionics fit, including the radar with a Model B1.01 phased-array antenna, and a full armament system. The aircraft made its maiden flight in May 1976 in the hands of Pyotr M. Ostapenko; at the end of the year it was turned over to GNIKI VVS in Akhtoobinsk to undergo state acceptance trials, which are described later in this chapter.

Around 1979 the first prototype MiG-25MP ('831 Blue') was transferred to LII where it served as an engine testbed, helping to refine the production-standard D30F-6 engine. Eventually the aircraft ended up as a ground instructional airframe at one of the Soviet Air Force's flying colleges – probably the one in Daugavpils, Lithuania.

MiG-31 Production-Standard Interceptor (*Izdeliye* 01)

The Ye-155MP was undoubtedly superior to all interceptors then in Soviet Air Defence Force service as far as range, armament and the capabilities of the avionics suite were concerned. Therefore, as early as 1974, with several years of trials still to go, a decision was



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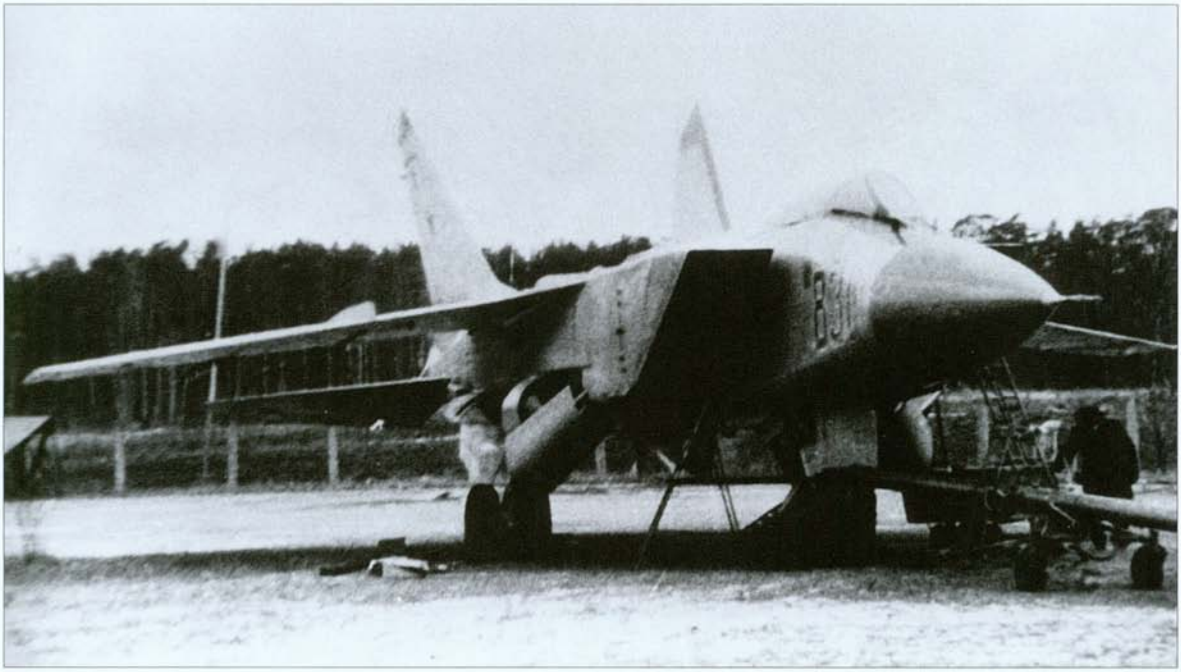
The centre fuselage of the '83/1', showing the unusual staggered-tandem main landing gear bogies and the forward main gear door segments suspended on skewed hinges to act as airbrakes – a feature of the two prototypes.



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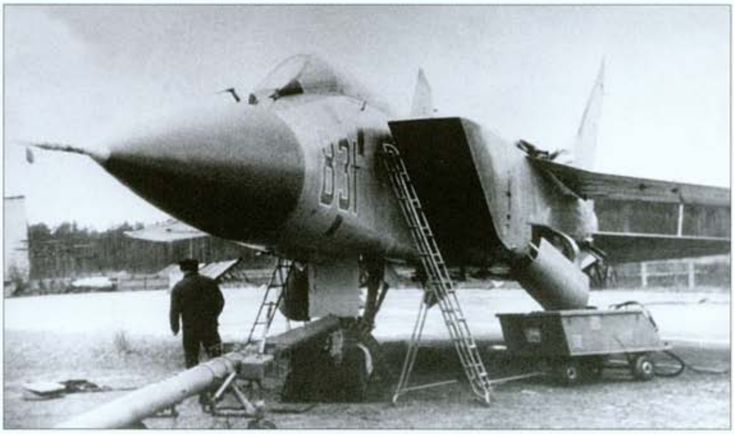
taken to launch full-scale production of the new interceptor at aircraft factory No.21, named after Sergo Ordzhonikidze, in Gor'kiy – the plant which had built the MiG-25 earlier. (In post-Soviet times it became the 'Sokol' (Falcon) Nizhniy Novgorod Aircraft Factory.) The production version of the MiG-25MP received a new service designation, MiG-31.

Changes to the manufacturing drawings (based on the early test results) were made and the tooling up for production was done concurrently with the tests of the Ye-155MP prototypes. In 1976 the Gor'kiy aircraft factory's own design bureau – the second in the plant's history – was organised in keeping with an order signed by the Minister of Aircraft Industry; it was headed by Chief Designer Ye. I. Mindrov.

In 1977 the first two production MiG-31s rolled off the assembly line in Gor'kiy. Known at the factory as *izdeliye* 01, the production version differed from the two prototypes as follows. The TE flap span was increased, while horizontal tail area was reduced by deleting the so-called 'knives' (bendable trim tabs) on the trailing edges of the all-movable tailplanes (stabilators); the angle between the stabilator axles and the fuselage axis was also reduced, as were the stabilator travel angles. The vertical tail arm was increased by moving the fin/rudder assemblies aft. The main gear door design was altered so that the airbrakes became smaller but opened to a greater angle, moving in the vertical plane parallel to the plane of symmetry.

Soviet/Russian aircraft production is normally organised in batches containing a more or less constant number of aircraft. Batch 1 of the MiG-31 consisted of only two aircraft – the above-mentioned first production machines. Typically of Soviet aircraft after 1973, the actual construction numbers (manufacturer's serial numbers) of production MiG-31s do not tell much, the eleven-digit c/n ending in a computer-generated five-digit sequence



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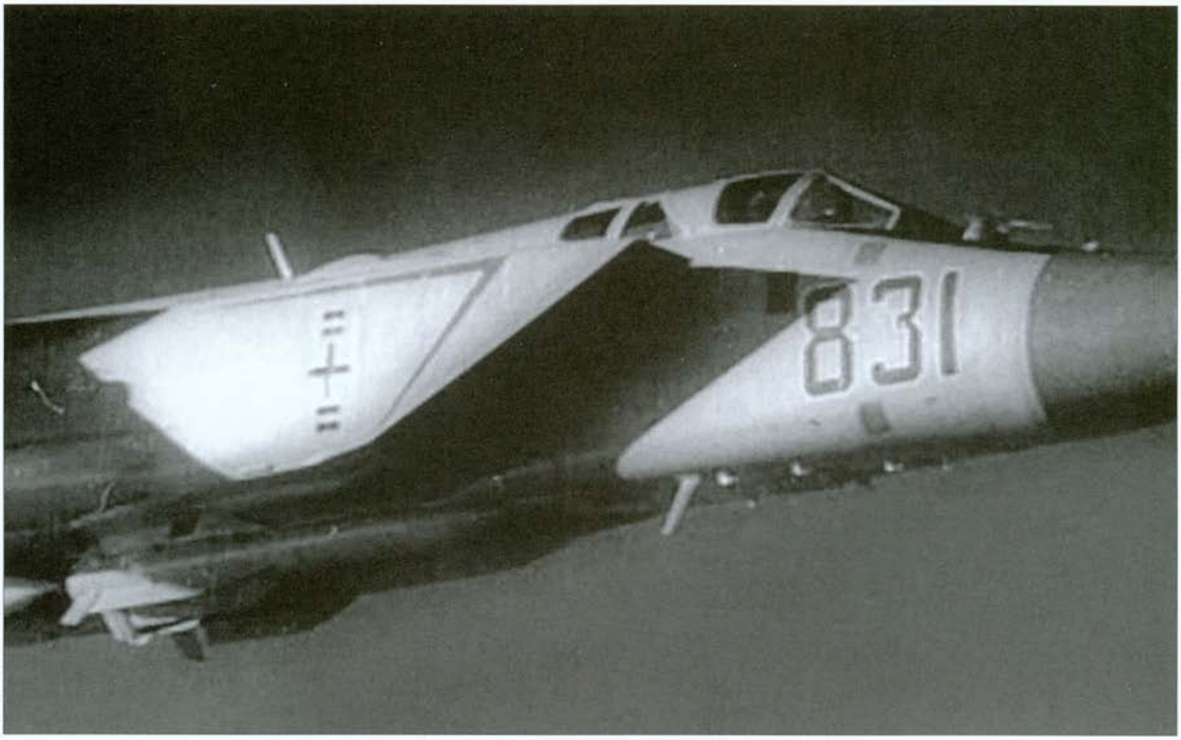
Upon completion of the flight test cycle the first prototype Ye-155MP was transferred to the Flight Research Institute (LII) at Zhukovskiy for use in various research and test programmes.



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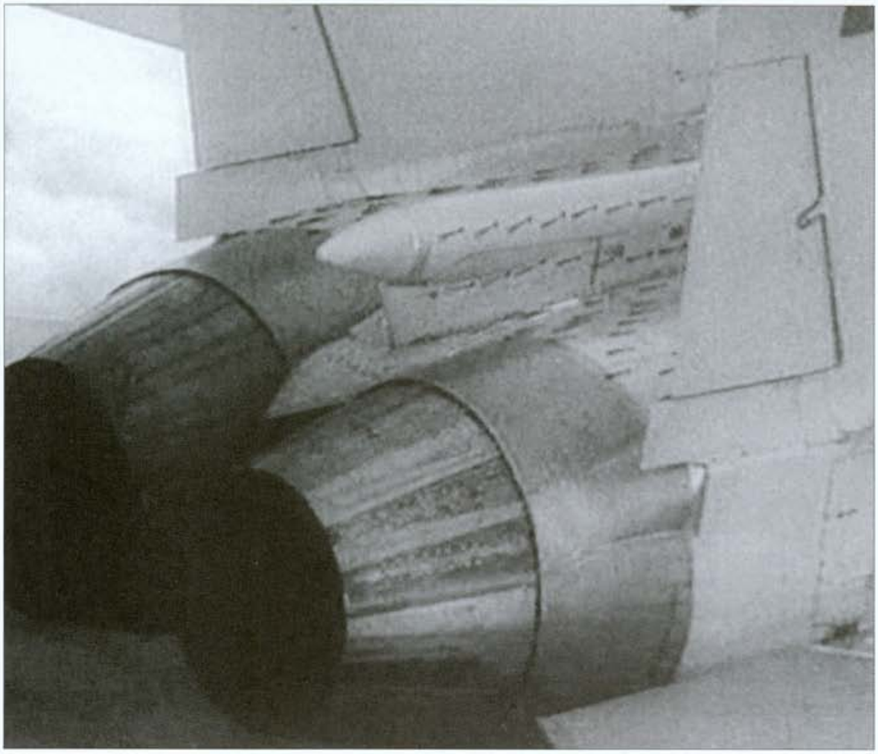

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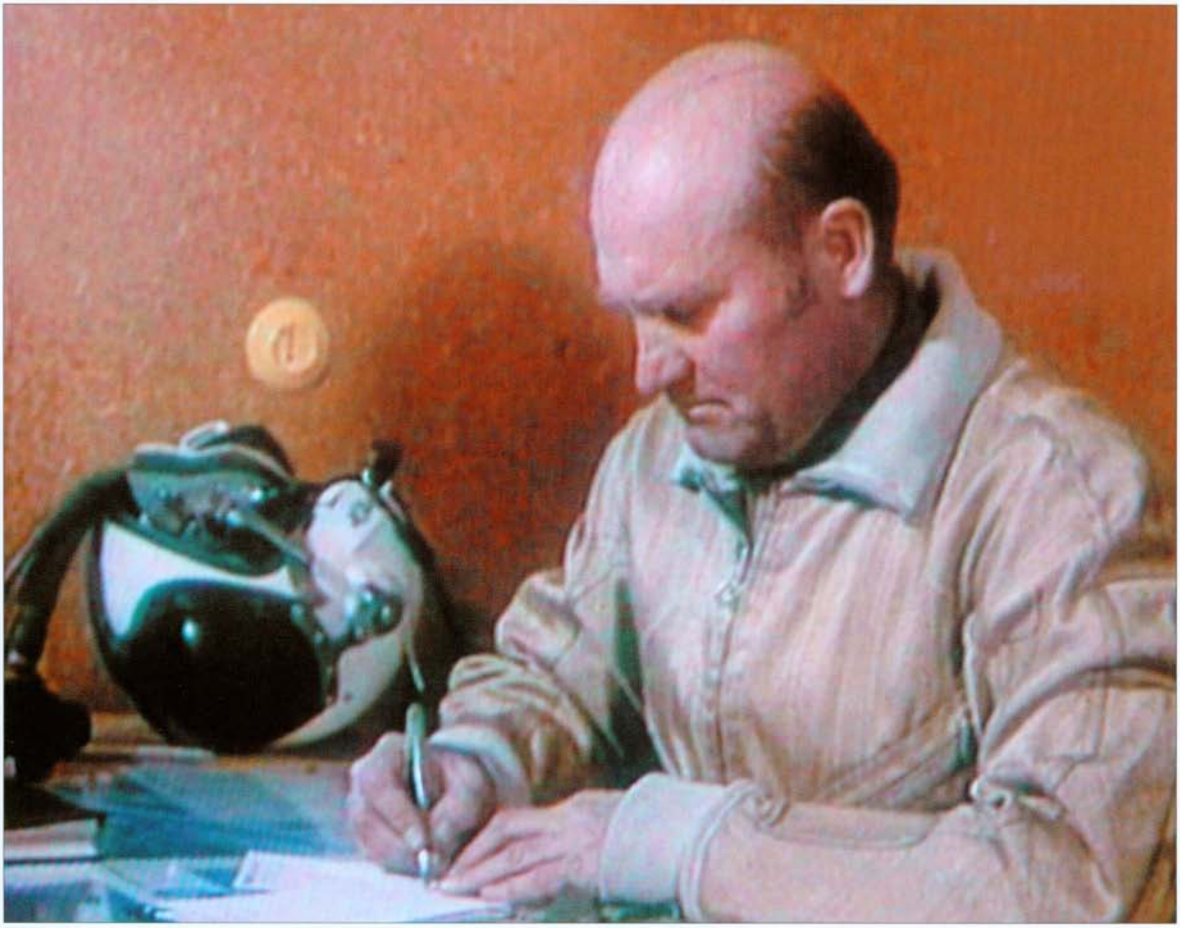
▲
A rare air-to-air shot of the first Ye-155MP. Note the photo calibration markings on the air intake trunk.

◄
This interesting close-up shows the wool tufts attached to the rear fuselage of the '83/1' for airflow visualisation. Note also the boattail shape of the fuselage between the engine nozzles.

►▲
Left to right: Pilot Pyotr M. Ostapenko, Hero of the Soviet Union; navigator Boris A. Orlov, Hero of the Soviet Union; and navigator Vladimir S. Zaitsev. These Mikoyan OKB airmen flew the MiG-31 at the early test stage; Zaitsev received the HSU title posthumously...

►
Mikoyan OKB chief test pilot Aleksandr V. Fedotov signs a flight assignment form. He was killed in a MiG-31.



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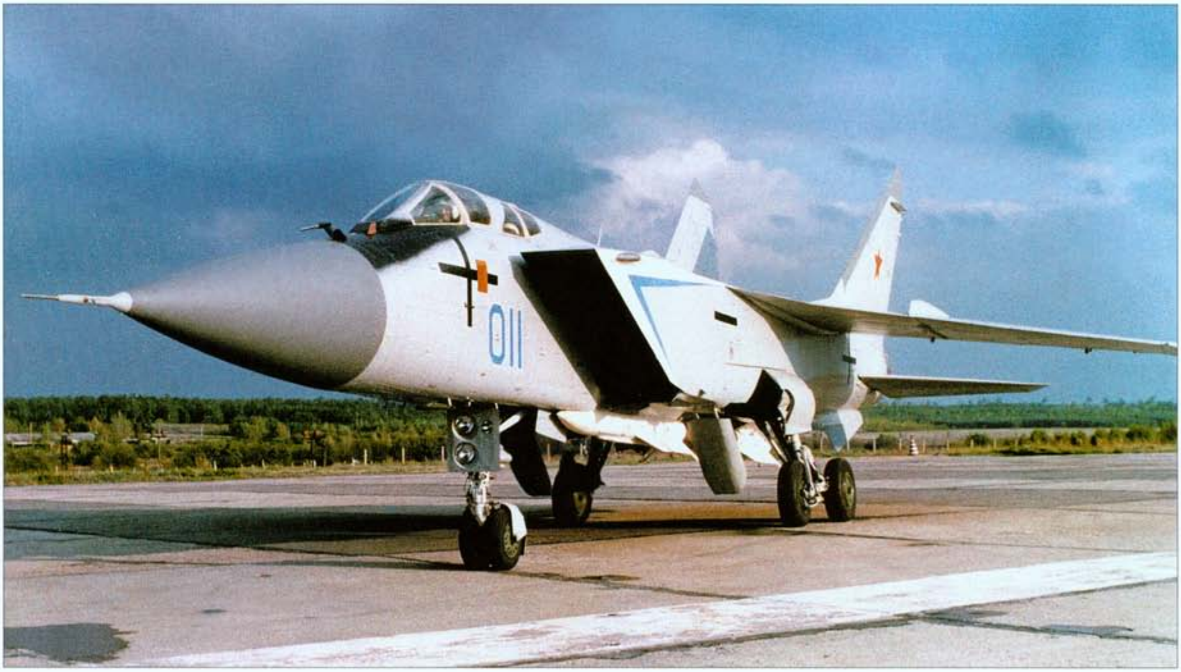


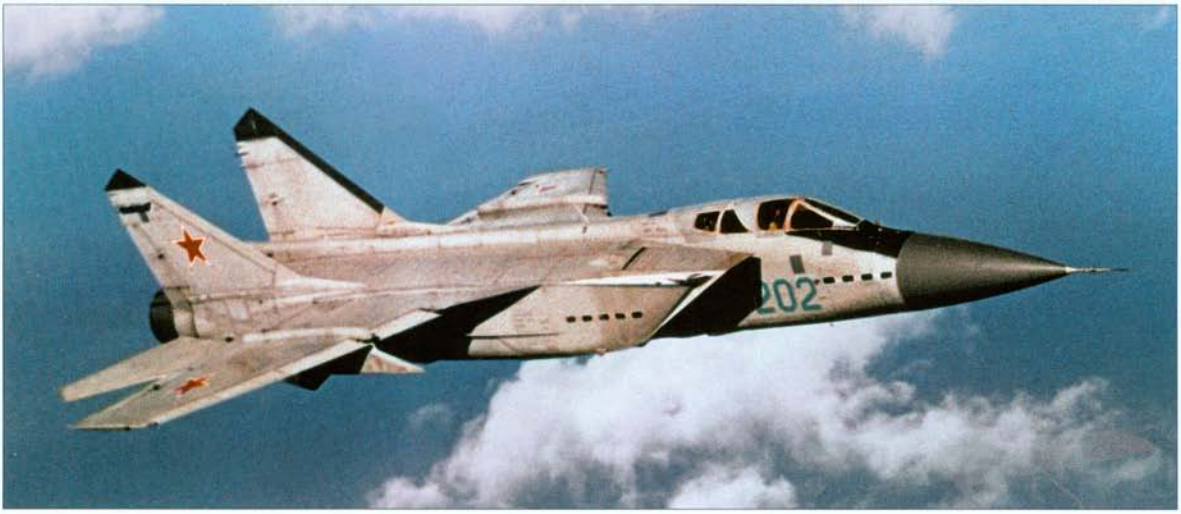
RSK MiG

▲
'011 Blue', the first production MiG-31 (f/n 0101). The different main gear door design is obvious, the airbrakes now deploying vertically down. Note the photo calibration markings on the fuselage.

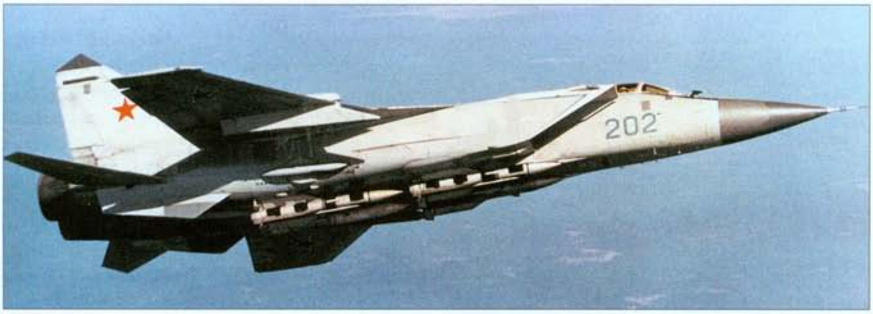
'202 Blue' (c/n N69700102176, f/n 0202), the fourth production MiG-31 (*izdeliye* 01).
▼

meaning nothing at all so as to avoid revealing how many have been built. Hence the aircraft have a parallel system of four-digit fuselage numbers (line numbers) for in-house use consisting of the batch number and the number of the machine in the batch. Thus the first production MiG-31 released by the factory in the late spring of 1977 was coded '011 Blue' (f/n 0101), while the second aircraft ('012 Blue') manufactured in the autumn of 1977 was f/n 0102. '011 Blue' was the first MiG-31 featuring production-standard aerodynamics. Like the first prototype, it had no radar, being used for stability/handling, fatigue and structural (dynamic strength) tests. The second aircraft was fully equipped and intended for checking the capabilities of the aerial intercept weapons system as a whole.

Batch 2 comprised three aircraft coded '201 Blue' through '203 Blue' (f/ns 0201, 0202 and 0203); Batch 3 consisted of five machines ('301 Blue' through '305 Blue', f/ns 0301

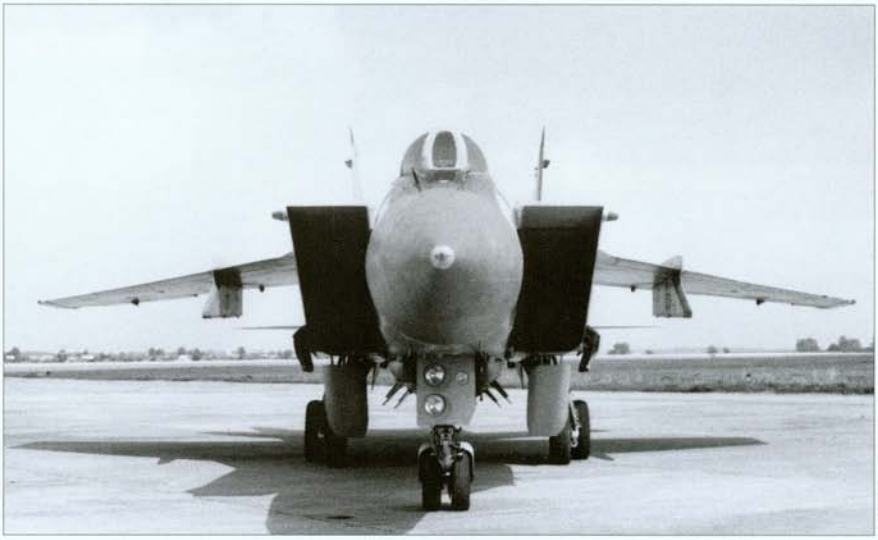


RSK MiG

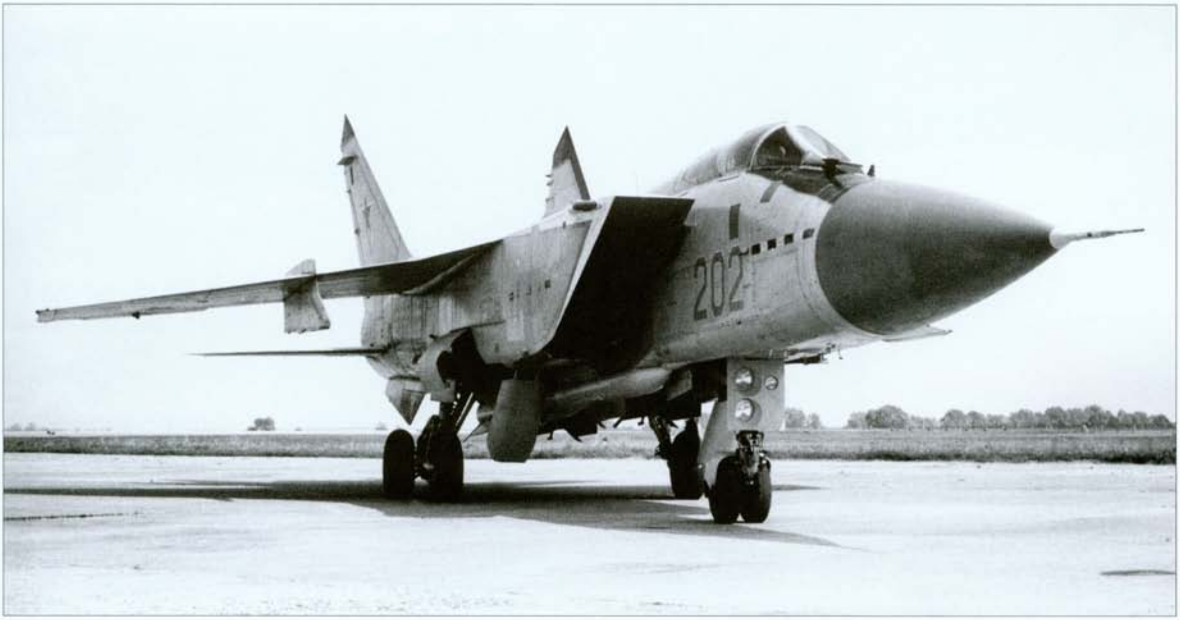

RSK MiG

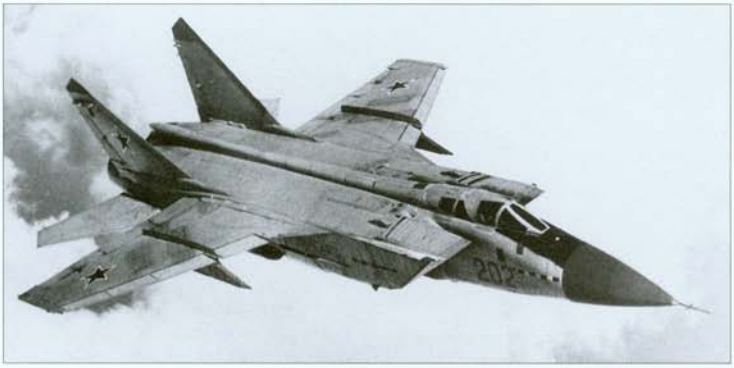
◄
Although '202 Blue' was used for live weapons tests, the black bands on the R-33 missiles carried in this particular flight identify them as dummies. The fairing of the cannon on the starboard side is clearly visible.

►
This full frontal of '202 Blue' illustrates the MiG-31's large-area boxy air intakes and the staggered track of the mainwheels reducing the ground pressure during (theoretical) soft-field operations.


RSK MiG

'202 Blue' was one of several examples involved in the MiG-31's state acceptance trials. Note that the photo calibration markings and the blue/white trim on the intakes are different from the prototypes and '011 Blue'.
▼


RSK MiG

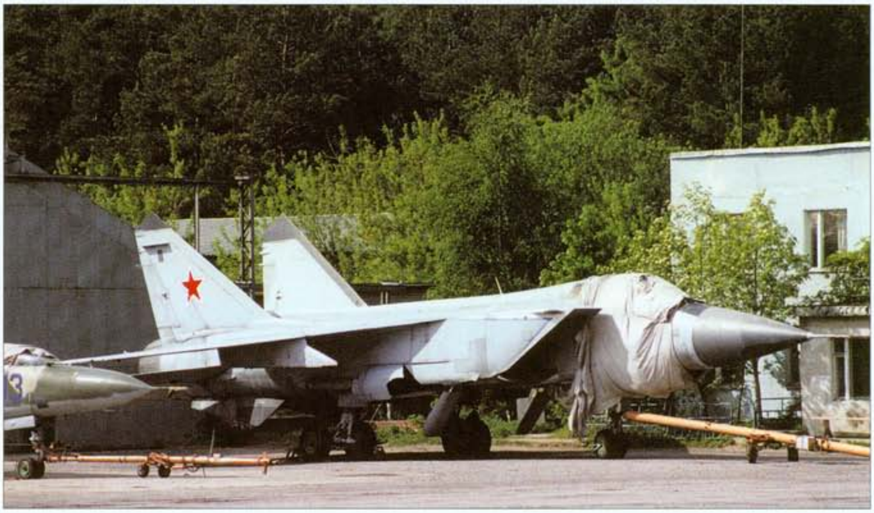


RSK MiG

▲
Another aspect of '202 Blue' cruising above the clouds, showing the wing fences and the brake parachute fairing.

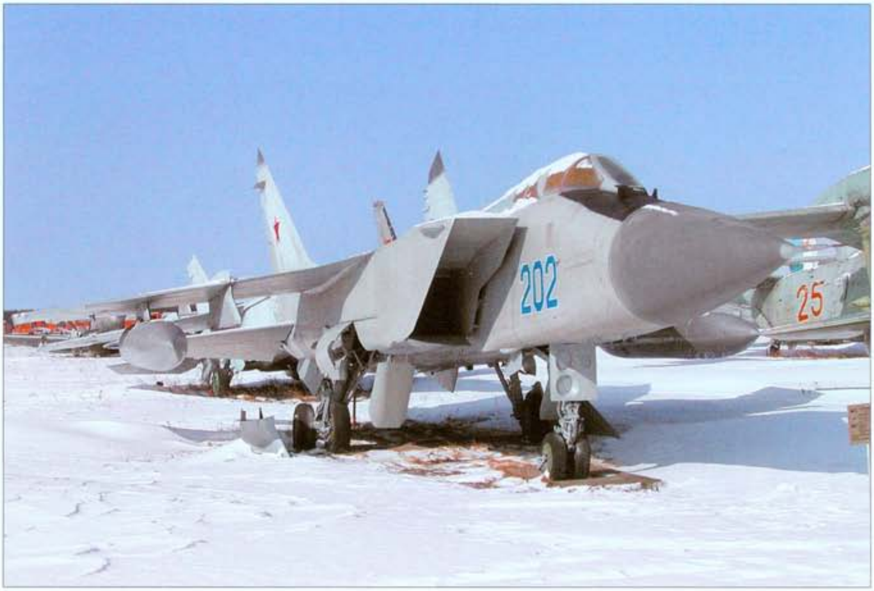
through 0305). These eight interceptors were also earmarked for test and development purposes. All of these aircraft had pale blue codes.

Stage A of the MiG-31's joint state acceptance trials – that is, the manufacturer's flight tests performed chiefly by the OKB – commenced in May 1977. At this stage the production aircraft of Batch 2 and most of Batch 3 (f/ns 0201 through 0203 and 0301 through 0303) joined the programme one by one as they were released by the factory. Mikoyan OKB engineers L. I. Sviderskiy and E. K. Kostroobskiy were the engineers in charge for the MiG-25MPs which also took part in the state



Yefim Gordon

►
After completing the state acceptance trials programme MiG-31 '202 Blue' sat unwanted for several years at the ANPK MiG hardstand in Zhukovskiy until it was finally donated to the Russian Air Force Museum in Monino.



Marcus Fulber

►
Snowbound, the fourth production MiG-31 sits in the open-air display at what is now the Central Russian Air Force Museum. The calibration markings and decorative blue/white trim have been removed.

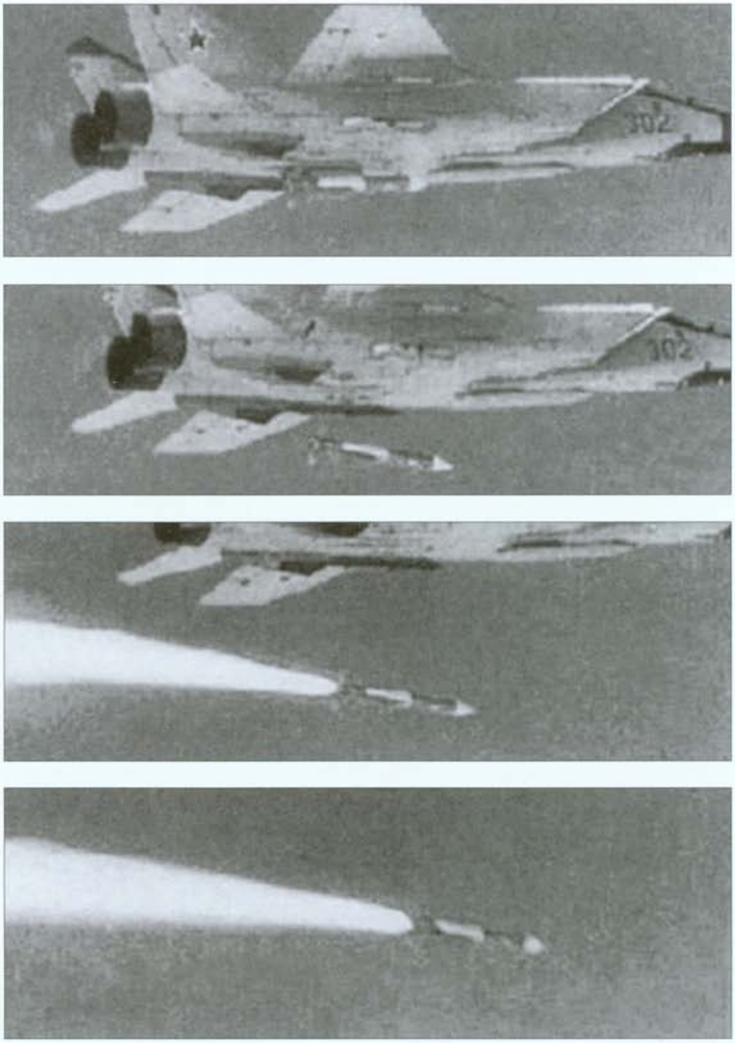
acceptance trials. Overall technical supervision on the part of the OKB was exercised by S. G. Polyakov (later succeeded by Kostroobskiy); A. B. Anosovich, A. M. Gherasimov, I. I. Kostyukovich, V. S. Yegorov, S. A. Boodkevich, B. M. Chak and A. M. Gherasimenko as the engineers in charge; OKB engineers V. A. Potoorenko, B. A. Krasnov, B. S. Losev, and specialists V. I. Kichev, V. M. Stroochkov, V. Ye. Starostin, V. V. Pripistsov, Yu. I Petrookhin, V. N. Pastukhov, V. S. Tomashevich, and others became involved with the programme later.

The joint test team included dozens of specialists representing not only the Mikoyan OKB but also 'subcontractors' and affiliated enterprises from the MAP, MRP and MOP frameworks and from GNIKI VVS who prepared the aircraft for, and participated in, the trials. An especially significant contribution was made by the specialists of NIIP responsible for the debugging of the Zaslon weapons control system. Virtually the entire flight test staff of the Mikoyan OKB took part in the trials of the MiG-31.

The testing of the initial production MiG-31s was by no means trouble-free. The engines were especially troublesome, requiring constant modifications and improvements. On one occasion '011 Blue' suffered an engine failure and Boris A. Orlov barely managed to land the crippled aircraft. Both the manufacturers and the test crews were aghast when they saw what had happened; as the engine came apart the fragments knocked out one of the hydraulic systems and many other equipment items – Orlov had been extremely lucky to make it back to base.

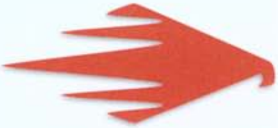
Stage A was completed in December 1978 and GNIKI VVS issued a so-called preliminary conclusion clearing the Ye-155MP for full-scale production as the MiG-31. Production really got going in 1979. That year the factory released the final Batch 3 aircraft, '305 Blue' (c/n N69700104801, f/n 0305), which was the first MiG-31 to feature the intended K-36DM ejection seats; all previous aircraft had been fitted with the old KM-1M seats. (Note: In MiG-31 *sans suffixe* c/ns, 697 is a code for aircraft factory No.21 (later changed to 384), 001 means *izdeliye* 01 (an extra zero is added to preserve the usual three-digit product code format used in construction numbers) and the rest is the 'famous last five' meaning nothing at all; the first two and last three of these digits accrue independently. The c/n is stencilled on the port wall of the nosewheel well.) '305 Blue' made its first flight from the factory's Sormovo airfield on 27th April 1979.

As mentioned in the previous chapter, in addition to the Ye-155MP (MiG-25MP) prototypes and the first production MiG-31s the trials programme involved several avionics and weapons testbeds. Specifically, two Tu-104 airliners converted in 1970 and 1972 for testing the Zaslon radar; and a MiG-21 and the tenth MiG-25P interceptor (the MiG-25P-10) modified in 1970 and 1973 respectively for testing the K-33 AAM. A MiG-25PU two-seat trainer served for verifying the SAU-155MP automatic flight control system and the KN-25 navigation suite in 1975. Finally, there were the two *izdeliye* 99 engine testbeds converted in 1976.

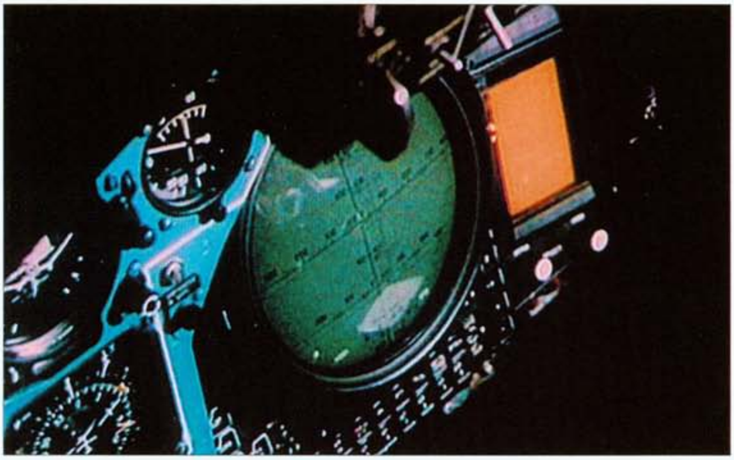


Yefim Gordon archive

▲ **This sequence of stills from a cine film shows an R-33 missile being launched by MiG-31 '302 Blue' (f/n 0302).**



The emblem of the Sokol aircraft factory in Nizhniy Novgorod (formerly the Gor'kiy aircraft factory No.21) which built many Mikoyan types, including the MiG-31.



Yefim Gordon archive

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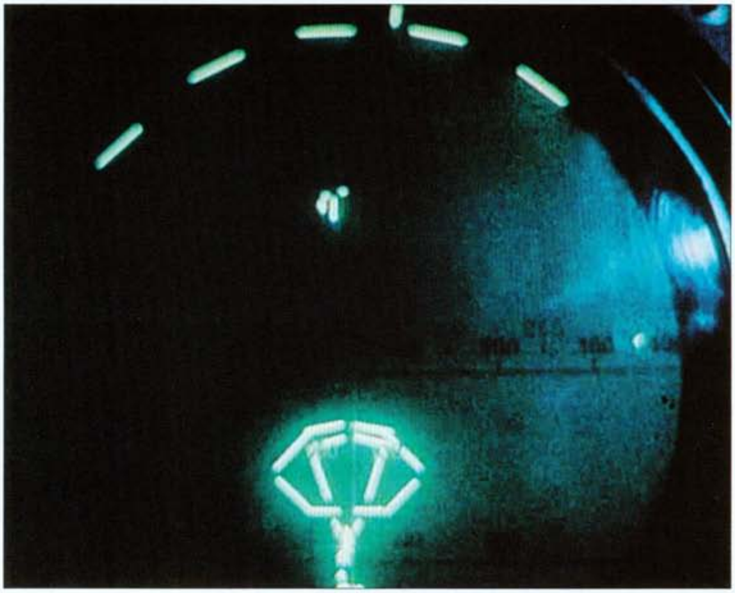
The pictures on these pages provide a rare possibility to visit the MiG-31's 'action stations' during a missile attack. Here, a look inside the WSO's cockpit shows the main radarscope with reference lines marked on it. So far so good – no enemies in sight.



Yefim Gordon archive

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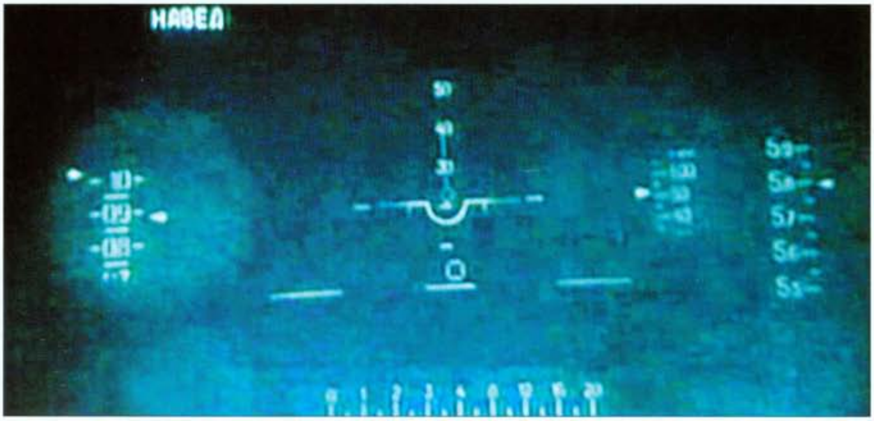
Alert! A target blip has appeared on the radarscope. The diagram at the bottom represents the fighter itself; the area in front of the fighter's own blip is probably the guaranteed kill zone for short-range IR-homing missiles. The curved hatched line at the top marks the limit of the Zaslon radar's detection range.

►

A diagram from the pilot's head-up display, with the aiming pipper in the centre, surrounded by scales marking the range and altitude.



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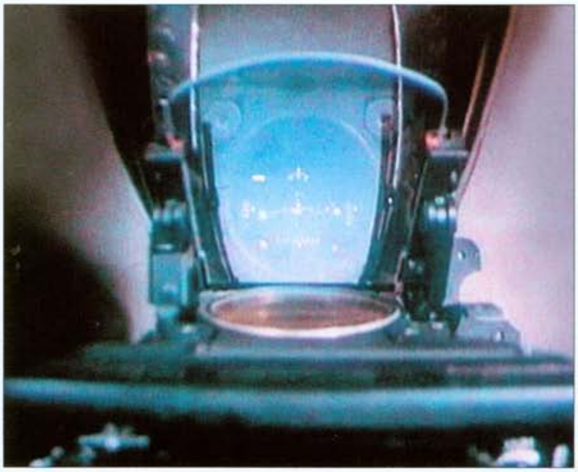

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▲
Another view through the PPI-70V HUD of the MiG-31 as the aircraft closes in on the target.

►▲
The crucial moment as the pilot holds his thumb on the missile launch button on the stick...

►
...and pushes it. Off goes the missile!

An R-33 missile streaks away towards the target, belching a long sheet of flame...
▼

...and finds its mark. Pop goes the target!
►▼

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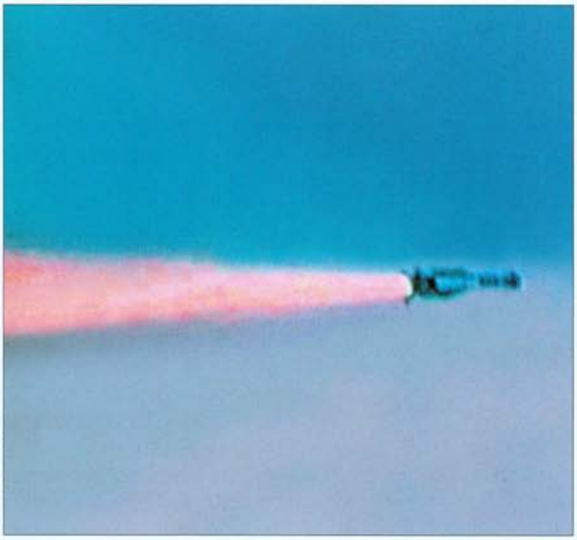

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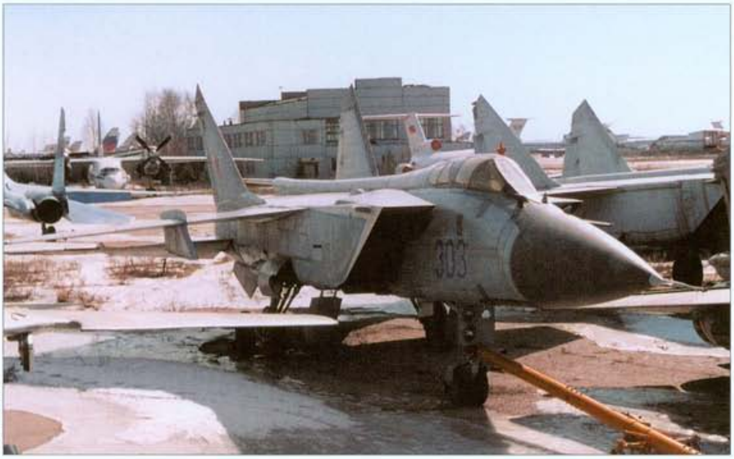
Mikoyan OKB test pilot Valeriy Ye. Menitskiy, who became chief test pilot after Fedotov's death in a flying accident. Menitskiy did a lot of test work on the MiG-31.

No longer airworthy, MiG-31 '303 Blue' (f/n 0303) languishes at the MAPO MiG flight test facility in Zhukovskiy in the mid-1990s, surrounded by other retired fighters and the company's 'hacks' – a Yak-40K feederliner and an An-32 transport.

▼ ▼



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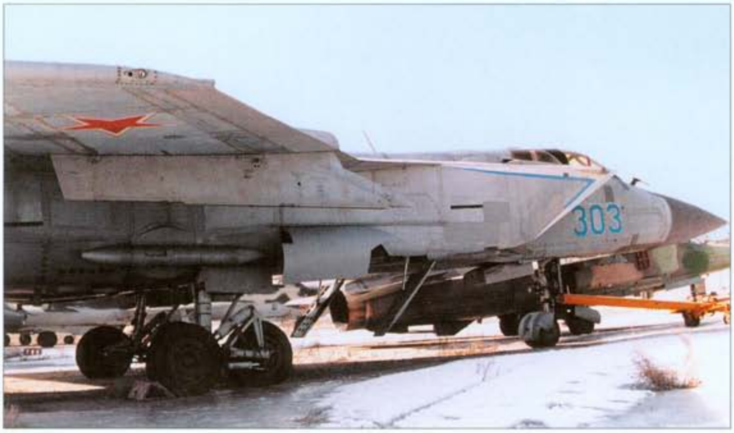


Yefim Gordon

Stage B of the state acceptance trials began in the spring of 1979, involving testing of the weapons system as a whole (primarily the weapons control system and the armament as such). Like Stage A, it was held at the GNIKI VVS facility in Akhtoobinsk (at Vladimirovka AB). The state commission appointed for the MiG-31's trials was chaired by Air Marshal Yevgeniy Ya. Savitskiy, the then Commander of the PVO's fighter arm and who had been a fighter pilot in the Great Patriotic War.

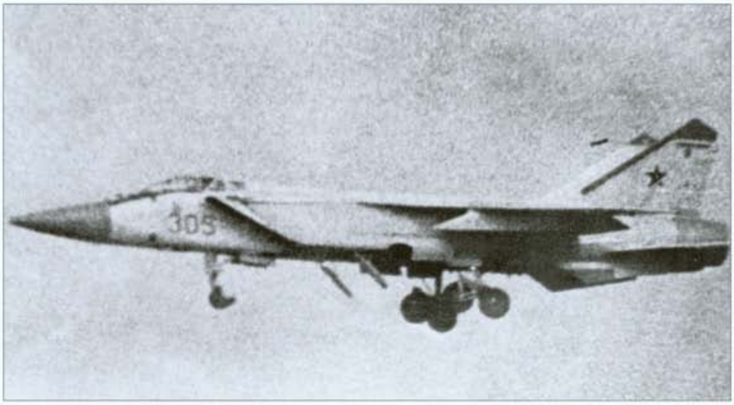
Gradually more Mikoyan OKB pilots – A. Krootov, Anatoliy N. Kvochur, Roman P. Taskayev and others – started test flying the MiG-31, which had entered full-scale production by then. On the whole the tests proceeded satisfactorily, although all manner of problems kept cropping up. On one occasion cracks appeared in the fuselage as the aircraft was pulling 5 Gs in a turn at Mach 2.6 and 15,000 m (49,210 ft) with Krootov at the controls. On another test mission, aimed at exploring the aircraft's structural strength, the nozzle petals of both engines failed when the MiG-31 was cruising in supersonic mode at low altitude. All failures and defects were carefully analysed and corrective measures were taken.

Speaking of pilots, more than once did they render invaluable help, saving their stricken aircraft by virtue of their exceptional bravery and skill. Taking the interceptor to the limit meant that the pilot had to go to the limit as well, which required stamina and good athletic training. Kvochur, for instance, few several five-hour missions to determine the aircraft's top speed and service ceiling. Imagine spending five hours in a pressure suit and oxygen mask, sitting strapped tightly into an ejection seat…

The first production MiG-31 was simply jinxed. Having had a narrow escape during Stage A of the trials, it ran out of luck during Stage B. On 20th September 1979, '011 Blue' was flying a routine test mission from Vladimirovka AB with pilot Pyotr M. Ostapenko and WSO Leonid S. Popov (using the callsign '631'). Shortly after take-off the RI-65 audio warning system (dubbed 'Rita' by the pilots) alerted the crew that the port engine was on fire. Notifying the tower, Ostapenko shut down the affected engine and made for home. The aircraft was fully fuelled and doing 1,000 km/h (621 mph) at 7,300 m (23,950 ft); the all-up weight was too high for an emergency landing, but jettisoning the fuel without knowing what was really burning and where would be unwise, to say the least. With a large fuel load and one engine out, the MiG-31 could only maintain level flight in afterburner mode; since reheat had to be cancelled in the event of an engine fire anyway, the aircraft started losing altitude. Twenty seconds later things got worse: the synthesised voice of 'Rita' announced that the other engine was on fire. Relighting the port engine, the pilot now shut down the starboard one, but the latter would not deliver more than 80% thrust and the turbine temperature started rising steadily. When it became critical the starboard engine was restarted in order to give the port engine a chance to cool down. Yet the altitude was getting inexorably lower and the starboard engine began overheating, too. When it became obvious they were not going to make it back to base, with no chances for a successful off-field landing, the crew ejected at 350 m (1,150 ft) – the minimum possible altitude. The emergency had lasted 6 minutes 54 seconds; the crew's actions were later judged to be entirely correct.

GNIKI VVS test pilots joined the action in 1977. The testing of the Zaslon WCS was accompanied by more than its fair share of problems (this is described in more detail below). Among other things, the instrumented test range in Akhtoobinsk had to be re-equipped so that the initial distance between the interceptor and the target in a head-on engagement would exceed 200 km (124 miles). New telemetry pick-up and trajectory measurement systems had to be installed for tracking the flight of the two aircraft as they closed in on each other; care had to be taken to preclude mid-air collisions, since the trials programme included assessment of target tracking at minimum range, which meant the separation between the target and the interceptor could be as low as 1 km (0.62 miles).

The major problems encountered while testing the Zaslon weapons control system were caused by the need to test the system's performance in a multiple-target environment. Several targets came in head-on, maintaining prescribed intervals in the 'formation'; the intervals were selected to make sure that the targets would remain within the radar's field of view at all times, especially in 'look-down/shoot-down' mode when the radar beam was slanting downwards. As a rule, the test missions associated with the WCS were



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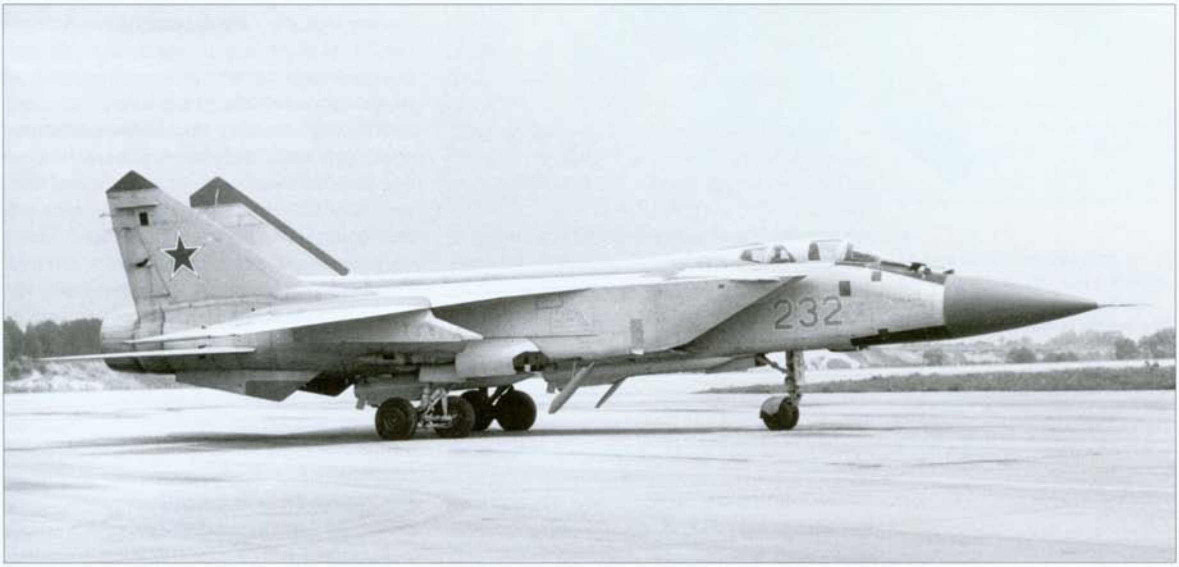
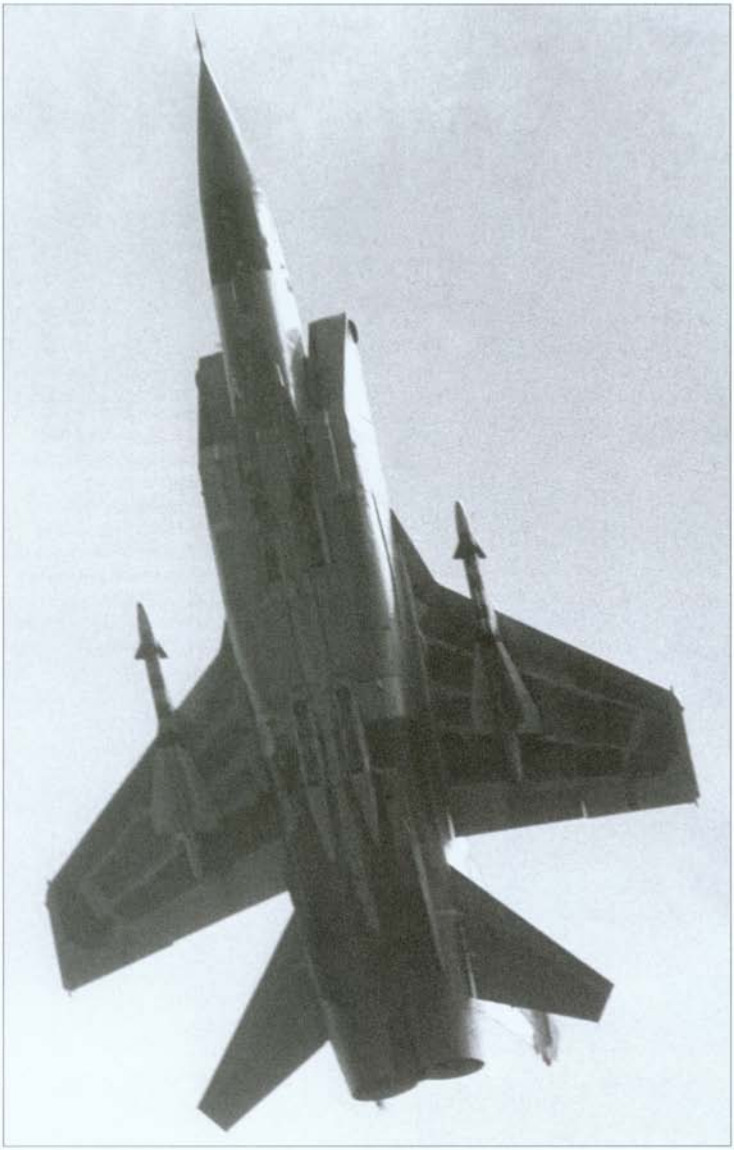
▲
Redolent with Cold War intrigue, this shot shows MiG-31 '305 Blue' (c/n N69700104801, f/n 0305) on final approach to Zhukovskiy. This aircraft was the first *Foxhound* to be equipped with Zvezda K-36D zero-zero ejection seats. Note the no-load position of the main gear bogies with the noses up.

'232 Blue', a production MiG-31 delivered to the Mikoyan OKB for further test work.
▼



RSK MiG



Victor Drushlyakov

▲ **This still unpainted MiG-31 carries a pair of R-40TD missiles on the wing pylons. The key to this puzzle is that the interceptor was photographed during a pre-delivery test flight from the factory airfield (Gor'kiy-Sormovo) and the missiles are in fact dummies.**

combined ones, involving the checking of several of the radar's parameters at once. After successful sorties in which the targets were destroyed, even highly experienced pilots were awed by the new interceptor's capabilities. This is how Col. V. N. Kandaurov, holder of the Merited Test Pilot grade and Hero of the Soviet Union title, recounts the days when he test flew the MiG-31 in his book *A Runway As Long As A Lifetime:*

How did a live weapons test mission look in which four target aircraft were actually destroyed, you may ask? Well, I sat in the cockpit, yawning with boredom and not knowing what to occupy myself with. We had been following a heading of 090° magnetic for about half an hour, cruising at optimum speed and altitude. Somewhere out there ahead of us there were supposed to be four target drones flying in a strip 50 km [31 miles] *wide. There was not a soul in the air; you got the feeling you were completely alone in the boundless sky. […] At length I could stand it no longer and pushed the intercom button.*

'Kolya (the short/familiar form of the name Nikolay – Auth.), *I'm sick and tired of sleeping. How are you doing back there? What are you doing?'*

'I'm asleep,' my navigator N. Volkogonov said in a low voice.

'Well I never!' – I was unable to contain my surprise. 'We're both asleep! Who's working, then?'

'The Zaslon is, in automatic mode. So far we have to sit back and wait.'

I looked at the weapons selector panel once again. Everything is armed and the missiles are ready for launch. Another five minutes passed in silence. Suddenly a target 'blip' appeared on the HUD glass, accompanied by an 'Attack' marker and a range scale.

'Target One, top priority threat, at 11 o'clock. Get him, captain,' – I heard my navigator say.

I change course to get my pipper onto the target and immediately find myself within range. Tally-ho! Away goes the missile!

No sooner is the missile off the rail than a second target pops up, away to the right. I make a vigorous turn and put the aircraft into a dive to keep the pipper on the target. The target is 40 km [24.8 miles] *out and the maximum launch range is 30 km* [18.6 miles]. *With seven or eight seconds to spare, I have time to check the engines. 'So, that means the next two are going to be even lower-priority threats and I will have time for manoeuvring,' – I thought calmly as I fired the second missile. Twenty seconds later it was all over.*

'Captain, all four bad guys are down, let's go home. There's nothing more we can do here,' – Nikolay's satisfied voice comes through the headphones.

'Yep,' – I answer. – 'It was easy to the point of being disgusting.'

Nonetheless, it was exactly the operation of the Zaslon WCS in general and the radar in particular that the customer (the PVO) voiced the greatest complaints about. Here it has to

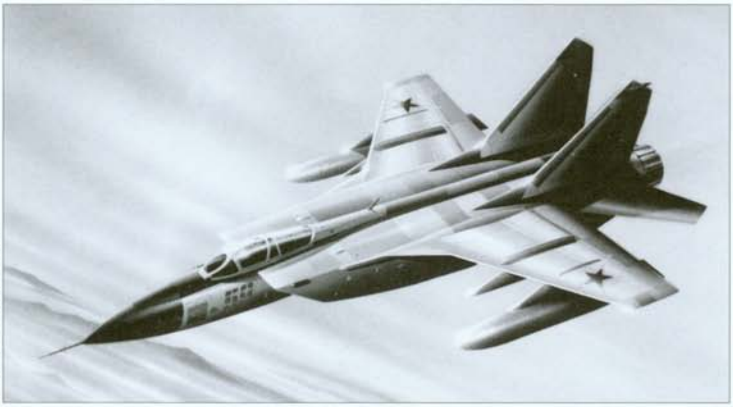
Victor Drushlyakov

▲
Another MiG-31 making a pre-delivery test flight, quite possibly its first, and without missiles in this instance. It was common practice at Soviet aircraft factories to apply the paintwork after the aircraft had made at least one test flight.

be said that Section 13 of GosNII AS played a major part in supporting Stage B of the trials and debugging the Zaslon WCS. A special team of analysts composed of GosNII AS staff and employees of the OKBs responsible for the system's components was set up to assess the results of the trials in Akhtoobinsk. It was headed by V. S. Zinich who contributed a lot to the research work done at all stages of the new weapons system's development. Section 13's direct involvement in the development of the S-155 aerial intercept weapons system dated back all the way to 1974 when it analysed the test results obtained on a Tu-104LL avionics testbed featuring components of the Zaslon WCS.

State commission chairman Air Marshal Yevgeniy Ya. Savitskiy visited the analytical team more than once at the testbed's current base to check up on progress. Following the example of Chief Designer V. K. Grishin, who flew in the Tu-104LL whenever he had a chance, several GosNII AS Section 13 employees and the staff of I. B. Tarkhanov's laboratory (which was part of the institute's Section 2) requested permission to fly in the testbed, too. To do so they needed a special permit from LII, which was issued after a thorough medical check, a theoretical training course followed by an exam and, in theory at least, a parachute jump training course – just in case they would have to bail out. Only half of the applicants were fit enough to pass the medical check; on the other hand, they were saved the trouble of jumping.

In 1975, even before the MiG-31 entered state acceptance trials, a large team of GosNII AS employees started developing software designed for data processing on the M-6000 digital computer. Originally programmes and data to be processed could be loaded into the M-6000 only by means of punched tape, and the work efficiency was accordingly very poor, despite the lots of time and effort spent. Later, in 1976, thanks to Section 13's efforts, the Soviet Union's first primary flight data



Jane's All the World's Aircraft

▲
An early artist's impression of the MiG-31 published by the Western aviation media. The drawing is reasonably accurate, being based, no doubt, on satellite imagery. The major inaccuracies are in the cockpit area; also, external tanks (which are ferry tanks, not drop tanks) can be carried on the inboard pylons only.

processing complex permitting automatic data entry from the K60-42 magnetic flight data recorder was built in Akhtoobinsk and the algorithms of secondary data processing/mathematical analysis were implemented on the YeS-1022 computer. (The computers in question were stationary affairs housed in several large cabinets.)

It deserves mention that the Council of Ministers had issued a directive requiring a bench testing complex (BTC) to be created at GNIKI VVS for supporting the testing and refining of the S-155 weapons system. Among other things, the BTC was intended to be used for the following:

- pre-mission and post-mission simulation in order to specify and refine the mission profile and perform a qualitative analysis of test flight results;
- training the flight crews involved in the trials, primarily for the purposes of teaching them to use the data presentation/control environment in the cockpits, practising various mission profiles before the real thing, simulating specific malfunctions and working out ways of countering them;
- performing specific tasks envisaged by the operational mode simulation programme developed for the S-155 weapons system (this was part of the flight test programme);
- verifying the system's built-in data recording equipment used for debriefing or accident investigation;
- maintaining a 'hot reserve' of the system's electronic components and modules (that is, keeping them in working condition, regardless of whether or not they were used for simulation purposes.

In late 1976 the efforts to build a full-scale BTC in Akhtoobinsk featuring virtually the MiG-31's entire avionics fit were stepped up dramatically. Since the tasks which the complex was to fulfil were extremely varied (including radar performance testing in various modes, testing of the cockpit indication system, navigation suite and data link system, systems integration, training, pre-mission and post-mission simulation etc.), a separate GosNII AS team was assigned to each of the BTC's aspects.

In early 1977 the complex 'came alive'. The S-3-800 ground test rig was linked to the appropriate mathematical models, allowing work on assessing the radar beam's stabilisation accuracy to get under way. The greatest successes were achieved in 1978 in various aspects; 30% of the BTC's operational time was devoted to radar performance testing and 21% to integrated task simulation; 20% of the time was downtime while the hardware was being repaired; while another 17% was spent on exploring the radar's very high frequency radiation. GNIKI VVS engineers R. B. Yugai and S. P. Zinchenko participated actively both in the development of the BTC and in the research work performed on it.

One of the toughest tasks performed on the BTC was the pre-mission simulation of the simultaneous tracking of four targets, with simulated launches of four K-33 missiles; the complexity was partly due to the requirement that all four missiles were to be guided simultaneously. As a bonus, this complex assignment made it possible to solve isolated tasks, such as the priority threat selection algorithm and the possibility to alter the target destruction sequence without taking up additional time for the attack.

The mainframe computer of the Zaslon WCS featured a 'resident' electronically simulated target, which allowed the radar's operation and missile guidance mode to be tested on the ground. Apart from the airborne (radar-assisted) target search mode, the BTC made it possible to emulate other ways of guiding the interceptor towards the target (ground-controlled guidance and guidance from another aircraft) without using the Vozdookh-1M automated GCI system. The flight crews took part in all stages of the work.

To allow concerted action by groups of aircraft to be verified, the APD-518 data link system was included in the BTC's structure. By means of an external aerial the system maintained communications with development aircraft flying test missions. In one-way data link mode the aircraft would relay its co-ordinates to the BTC; these were then indicated on the tactical situation display. This mode made it possible to check the performance of the APD-518 and verify the complex technique of group operations without having to fly a second aircraft. The BTC also served for testing the data link system's ECM resistance, allowing the number of test sorties to be reduced appreciably.

The actions of GosNII AS Section 13 in support of the S-155 aerial intercept weapons system's flight tests continued throughout the state acceptance trials programme.

On 15th February 1978 a unique flight experiment was successfully held in Akhtoobinsk; it involved detecting and tracking ten aerial targets (Tu-16 and IL-28 bombers) flying at widely different altitudes in a strip about 150 km (93 miles) wide. On 28th August 1978 a MiG-31 destroyed four remote-controlled target drones in a four-missile salvo.

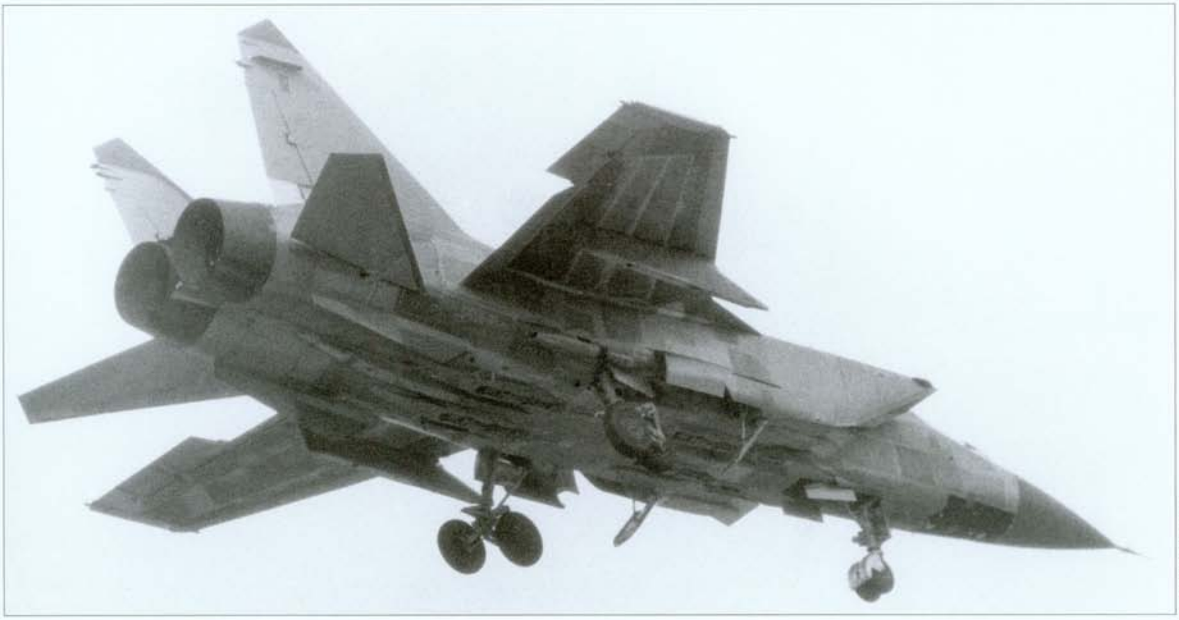
At the end of Stage B a quartet of MiG-31s demonstrated the possibility of group action to repel a hypothetical air raid against Volgograd (formerly Stalingrad). Ten radio-controlled target drones 'attacked' the city, spreading out across a swathe 100 km (62 miles) wide; all ten were shot down.

Stage B also included checking out the operation of the navigation suite in extreme northern latitudes. Before that the navigation suite had been put through its paces on a converted two-seat MiG-25 trainer by Boris A. Orlov and Leonid S. Popov. Flying from PVO airbases beyond the Arctic Circle, the MiG-25 was escorted by Tu-128 *Fiddler* interceptors from the fighter regiments at Amderma and Nar'yan-Mar as a safety measure in case the experimental navigation equipment should fail. One such mission on 17th July 1978 nearly ended in disaster when the two escorting Tu-128s collided in mid-air. One *Fiddler* made it back to Nar'yan-Mar; the other dived into the Arctic Ocean 60 km (37.25 miles) from the shore, out of control, but the crew ejected safely and were rescued by a Soviet ship.

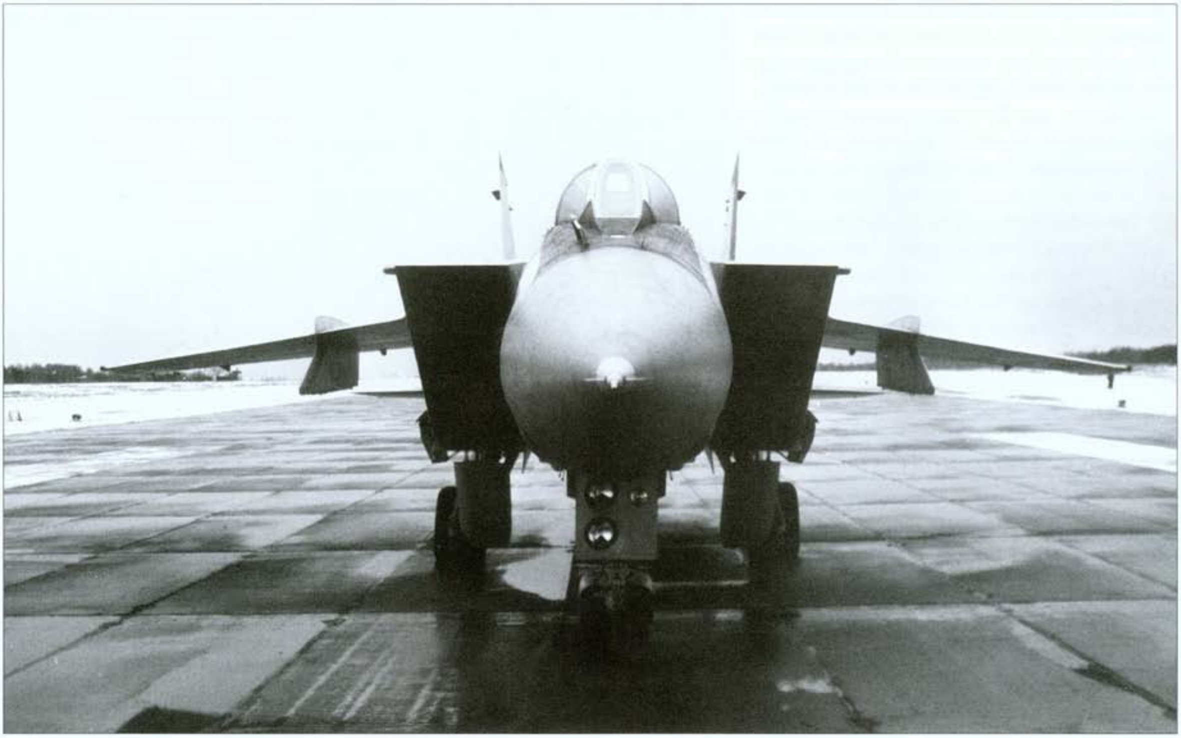
In October 1978 a US surveillance satellite recorded the successful destruction of a low-flying target drone by the new Soviet interceptor. This fact was dragged into public view, and the Pentagon's press secretary Thomas Ross, who had stated just a month earlier that 'there is no evidence that the Soviets are capable of shooting down cruise missiles or target drones simulating such missiles', had to eat his words.

The joint state acceptance trials of the MiG-31 interceptor, the Zaslon WCS and the K-33 AAM were duly completed in December 1980. The missile was added to the inventory as the R-33 or *izdeliye* 410; at the same time the manufacturer (the Vympel OKB) launched a programme to upgrade the missile which continued until the late 1980s. Finally, on 6th May 1981 the Soviet Council of Ministers

A brand-new and still unpainted MiG-31 is caught by the camera on final approach to Gor'kiy-Sormovo after a test flight. The different shades of metal give the aircraft a very patchwork appearance.
▼



Victor Drushlyakov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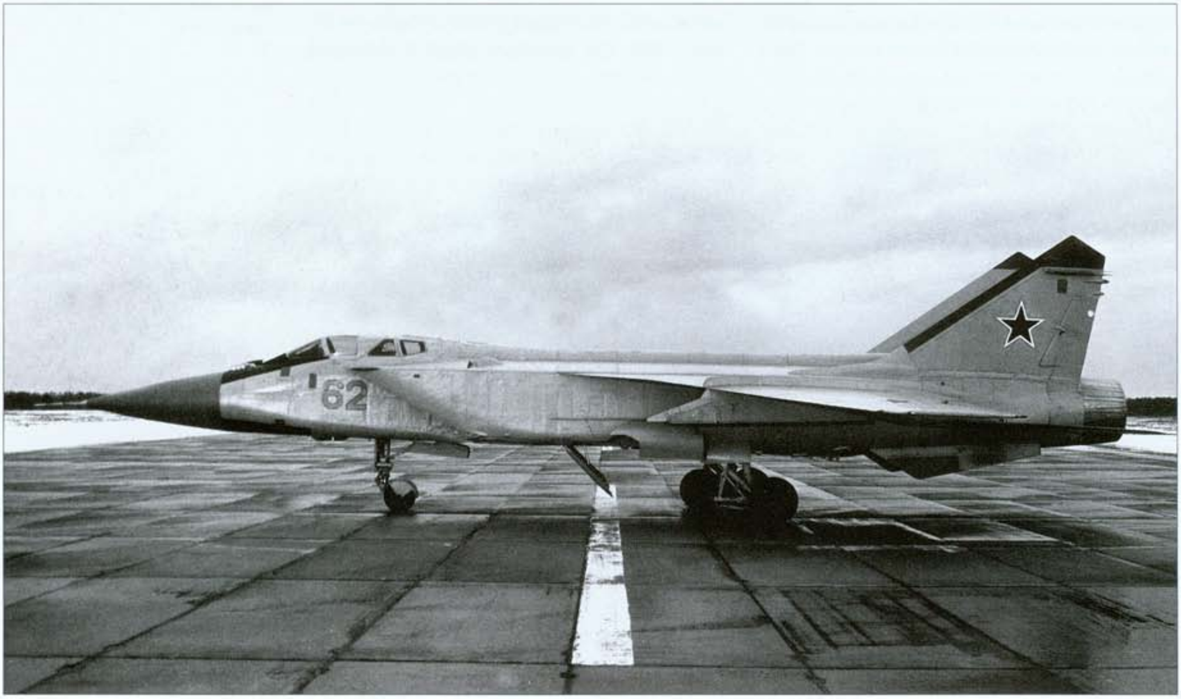
Three views of a typical production MiG-31 coded '62 Blue'. Aircraft operated by the Soviet Air Defence Force typically had blue two-digit tactical codes. The auxiliary air intake doors and other upper surface details are clearly visible in the picture on the right. ▼▲►



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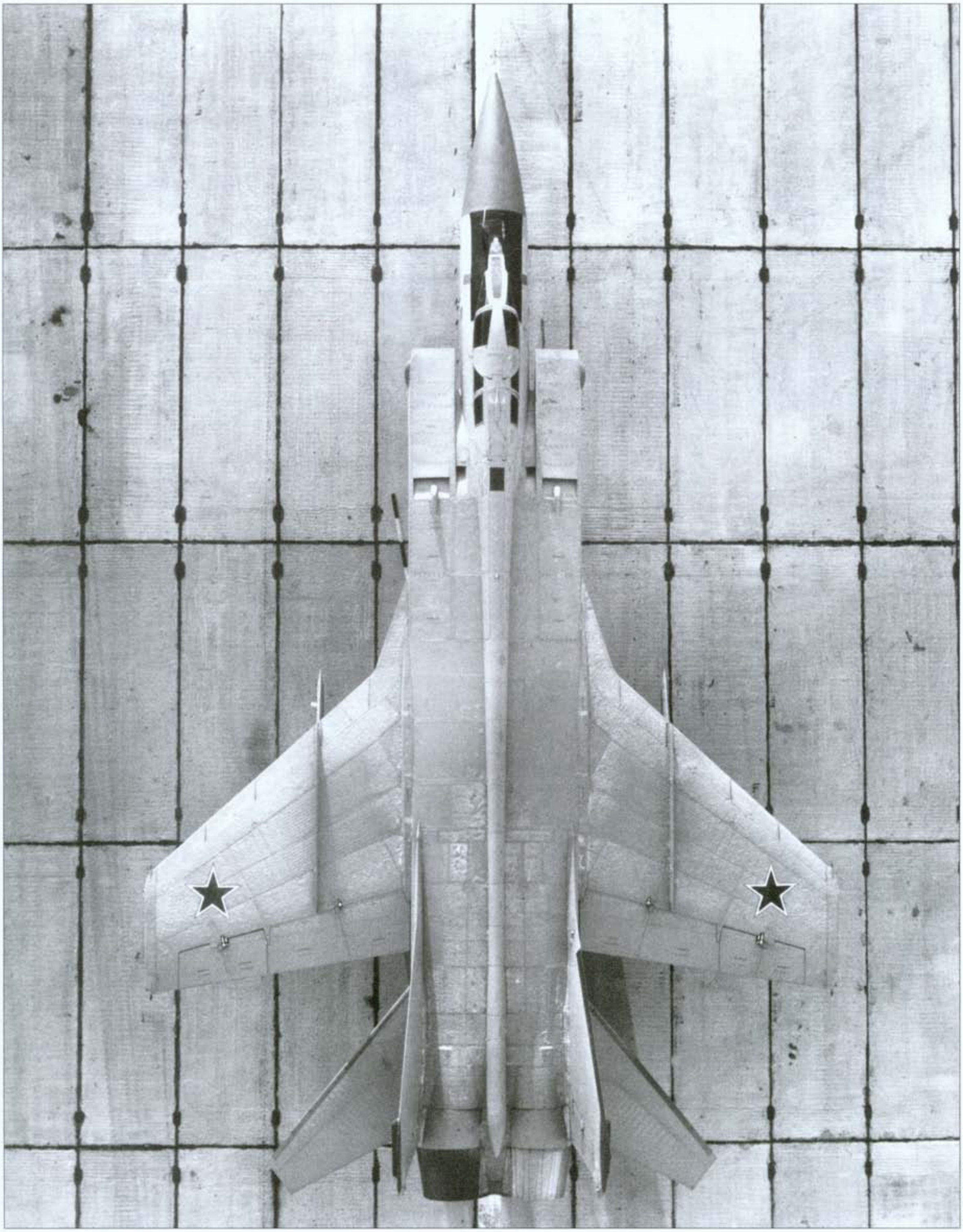

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issued a directive officially clearing the new aerial intercept weapons system for service.

Production MiG-31s had a weapons control system upgraded in accordance with the trials results; it included an MFBU-410 multifunction missile control module (***mno**go-foonktsio**nahl'**nyy blok oopravleniya*; the 410 is an allusion to the R-33's product code) designed under the supervision of I. Akopyan. The engines also differed considerably from those powering the prototypes, the production version being designated D30F-6S.

The efforts of those who created the MiG-31 did not go unrewarded. NPO Fazotron Chief Designer V. Grishin received the Hero of Socialist Labour title – the civic equivalent of the prestigious Hero of the Soviet Union title – for the development of the Zaslon fire control radar; the enterprise itself was awarded the Order of the Labour Red Banner, a very high distinction. The contribution made by NIIP to the development of the S-155 aerial intercept weapons system can be judged by the fact that 184 of the 400 aircraft industry employees who received government awards for this programme were NIIP employees. Several GosNII AS specialists received government awards for their part in the creation of the K-33 (R-33) missile, A. S. Sinitsyn being awarded the October Revolution Order.

In a manner of speaking, the MiG-31 propelled many men to high places and positions endowed with high responsibility. Soon after the interceptor's maiden flight Gleb Ye. Lozino-Lozinskiy became head of NPO Molniya. In 1976 Konstantin K. Vasil'chenko was promoted to MiG-31 project chief; when Vasil'chenko became Director of LII in 1985, this position passed first to Anatoliy A. Belosvet and then to Eduard K. Kostroobskiy.

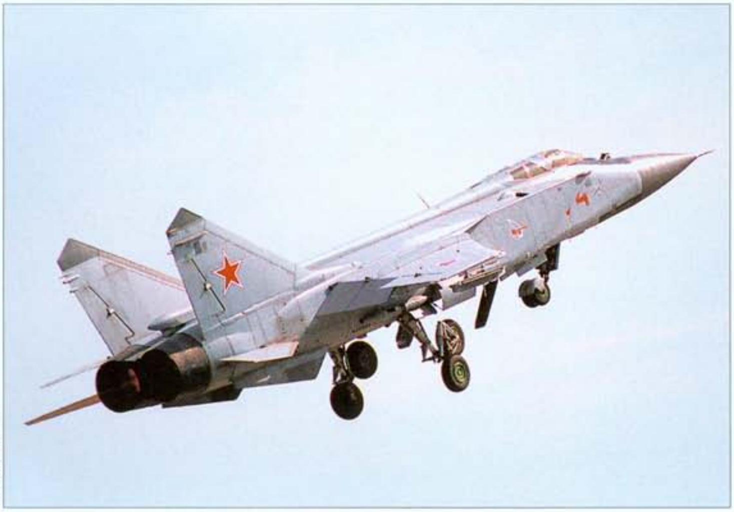
In early 1980 a handful of MiG-31s were delivered to an operational PVO unit for evaluation. Full-scale deliveries began in 1982; the early 1960s-vintage Tu-128 was the first type to be replaced by the new interceptor in first-line units. The first units to receive the MiG-31 were stationed in the Moscow Air Defence Zone, in the High North and in the Soviet Far East.

The new type's service entry was marred by accidents – both fatal and non-fatal. The engines and the fuel system proved equally troublesome at first. On one occasion MiG-31 '303 Blue' (f/n 0303), piloted by Valeriy Ye. Menitskiy, suffered a fuel line failure, the pipe bursting at the seam where a connector used for fuel pressure monitoring during ground runs was installed. Fuel under pressure gushed into the engine bay through a breach about 80 mm (3 in) in diameter; only the D30F-6's lower operating temperature in cruise mode as compared to the MiG-25's R15B-300 prevented a massive fire. Seeing the fuel supply was dwindling rapidly, the crew decided that the fuel jettison valve had opened uncommandedly. As the pilot headed back to base, shortly before landing the jet ran out of fuel and the engines quit. Menitskiy ordered his WSO V. V. Ryndin to eject, but Ryndin replied that he would do it only if there was no alternative, and then only together with his pilot. They did not have to; Menitskiy managed a safe off-field landing not far from the base.

Inspection of the other four Batch 3 aircraft showed that they all shared the same defect in the fuel system. After this emergency landing PVO Aviation Commander Air Marshal Yevgeniy Ya. Savitskiy filed a report to the Communist party Central Committee, urging that Menitskiy be awarded the Hero of the Soviet Union title. Yet, Menitskiy did not receive the award on that occasion because the Mikoyan OKB wished to keep the incident secret, as it was caused by faulty design for which the OKB's engineers could, and should, be punished. Alas, the saying that the heroism of some people is due to others' negligence is all too true...

Still, the narrow escape of '303 Blue' allowed the Mikoyan OKB to resolve many problems which potentially endangered the lives of MiG-31 crews in first-line units. Among other things, a redesign of the fuel system was

Wheels caught in mid-retraction, '74 Red', one of several MiG-31s operated by the Russian Air Force's 929th State Flight Test Centre, takes off on a demonstration flight from Vladimirovka AB, Akhtoobinsk, at the 'open house' on the occasion of the Centre's 75th anniversary in 1995. Note how the main gear bogies rotate nose-up as the gear retracts. ▼



Sergey Sergeyev

undertaken; the changes were to be verified on the third production MiG-31, '201 Blue' (f/n 0201), which was by then a long-serving 'dogship' with many hours on the clock. The decision to use a well-worn aircraft led to tragedy; on 4th April 1984 the modified MiG-31 crashed, killing Mikoyan OKB chief test pilot Aleksandr V. Fedotov and WSO V. S. Zaitsev.

This was one of the first post-modification flights; the mission was to check the fuel usage sequence. Less than two minutes after take-off a light lit up on the fuel status indicator panel, showing that the port wing tank was empty. The 'starboard wing tank empty' light followed suit 30 seconds later, followed by the light for the No.5 fuselage tank on the third minute of the flight and the indicators for both fin torsion box tanks on the fifth minute. The pilot opted for an immediate emergency landing, supposing that the fuel line was ruptured somewhere ahead of the engines. As the aircraft completed the downwind leg of the landing pattern, the flying control officer informed the pilot that the jet was not streaming fuel (which could mean that all fuel was already gone). Fourteen minutes into the flight, when the aircraft was doing 700 km/h (434 mph) at 1,200 m (3,940 ft) and about to turn onto final approach, the warning lights for the Nos 1, 2 and 6 fuselage tanks came on simultaneously. The incessant low fuel warnings reinforced the pilot's conviction that a fuel leak at a rate of about 1,000 kg (2,200 lb) per minute had developed. When the fuel management system indicated that available fuel was down to 2,200 kg (4,850 lb), the pilot, believing that this amount might be insufficient for the landing, decided to 'cut a corner'. As he made a turn at 550 km/h (341 mph), the MiG-31 stalled and flicked into a spin. There was not enough altitude for recovery and the pilot initiated an ejection – too late. The aircraft slammed into the ground just as the canopies came off – the ejection guns had no time to fire.

After this crash the Mikoyan OKB began a series of tests to explore the MiG-31's behaviour in dangerous flight modes. In particular, OKB test pilots Boris A. Orlov, Aviard G. Fastovets and Valeriy Ye. Menitskiy performed a spin trials programme. The result was a number of recommendations concerning aerobatic manoeuvres in such a large and heavy aircraft. The reader should keep in mind that the MiG-31 had been designed for beyond visual range (BVR) engagements, not for close-in dogfighting. This is why originally it had neither a stall warning system nor an angle-of-attack indicator; these useful features were introduced later on the MiG-31B (see below).

Sergey Sergeyev

▲
'74 Red' makes a formation flypast with a MiG-23UB trainer (the latter with the wings at 45° intermediate sweep) during the event. Note the orange-coloured efflux stained by nitrous oxide, a result of using nitrous fuel.

After Fedotov's death in harness Valeriy Ye. Menitskiy was appointed the Mikoyan OKB's new CTP. He had done a lot to make the MiG-31's service introduction with the PVO as smooth as possible.

As already mentioned, most production MiG-31s were equipped with K-36DM ejection seats which, unlike the KM-1M, possessed full zero-zero capability. The first aircraft so equipped, the abovementioned '305 Blue', underwent a large-scale dynamic strength test programme to see how the airframe stood up to the operational loads. In so doing the wings, air intake trunks and engine firewalls were reinforced on this aircraft, a new brake parachute container and a new fairing between the engine nozzles were fitted, and the radar was removed to make room for test equipment. Carrying dummy R-33 missiles, MiG-31 '305 Blue' effectively became the pattern aircraft for mass production as far as the airframe was concerned, undergoing tests in Zhukovskiy and Akhtoobinsk. Maximum-speed and maximum G-load missions were flown by Valeriy Ye. Menitskiy, Igor' P. Volk and other pilots. Eventually, however, this aircraft was also lost in a crash, with the crew captained by P. Gladkov ejecting safely.

One of the MiG-31's weaknesses was its relatively high landing speed. At a landing weight of 26,600 kg (58,640 lb), the approach speed was 285 km/h (177 mph), exceeding 300 km/h (186 mph) if the aircraft carried a lot of unused fuel and unexpended ordnance.

▶ Former Mikoyan OKB test pilot Roman P. Taskayev took part in the cross-country test flights involving in-flight refuelling that were part of the MiG-31's test programme. He now works for the Yakovlev Aircraft Company.

As already mentioned, full-scale production of the new interceptor in Gor'kiy began in 1979. Despite the initial series of crashes, the MiG-31 proved to be a fairly reliable aircraft in operational service. Very few engine fires were experienced in the course of trials and normal operations due to the engines' lower operating temperature as compared to the R15B-300.

The aircraft's capabilities as an interceptor were truly unique. The MiG-31 was the world's first production interceptor to have a phased-array radar. The latter was capable of detecting targets around the clock, in any weather, at altitudes between 50 and 28,000 m (165-91,860 ft); it enabled engagements in head-on and pursuit modes and had 'look-down/shoot-down' capability over both land and water. The radar could track up to ten targets at a time while guiding missiles to four priority threats within a sector of ±70° in azimuth and +70°/–60° in elevation. The infra-red search & track unit allowed targets to be tracked covertly and infra-red homing missiles to be used. Tactical situation displays in both cockpits gave the crew situational awareness. Special electronic support measures (ESM) equipment protected the interceptor from enemy ECM.

▶ Mikoyan OKB test pilot Aviard G. Fastovets also participated in the long-range flights that took the MiG-31 over the North Pole.

The principal armament comprised four R-33 long-range AAMs with inertial initial guidance, mid-course heading correction and active radar homing at the terminal guidance phase. This guidance algorithm was a 'world first'. The missiles were carried semi-recessed in the fuselage on pantographic racks. Other weapons options included two R-40TD (or R-40T) medium-range IR-homing AAMs or four R-60M agile short-range IR-homing AAMs, all on underwing pylons.

Mission success was ensured by a unique weapons control system. The MiG-31's avionics suite allowed it to act as an airborne command post or 'mini-AWACS' if need arose. A flight of four MiG-31s, with the flight leader acting as an ABCP, could swap information on targets detected within a swathe up to 800 km (496 miles) wide. The aircraft in the flight could distribute multiple targets between them or pass target information to the leaders of other interceptor flights; all data exchange proceeded in automatic mode, using secure channels. Three MiG-31s loitering in a designated area could provide full-time 360° coverage. The aircraft was capable of guiding up to three MiG-23P, MiG-25PD, MiG-29 or Sukhoi Su-27 fighters to their targets without revealing their presence by switching on the radars.

The variety of tasks performed by the interceptors was made possible in no small degree by the crew of two. The main reason for adding a second crewmember was the need to efficiently use the fairly complex weapons control system. The pilot (captain) was responsible for making the decisions, while the navigator/WSO made all necessary preparations for the engagement, working the data processing system controls in the rear cockpit. He plotted the aircraft's course and corrected it if necessary, processed target information, surveyed the airspace around the aircraft on the tactical situation displays and selected the targets in priority order. Using the telescopic control stick and rudder pedals, he could fly the aircraft in case of need.

For the first time in the Soviet Union, semi-autonomous action by groups of aircraft was possible, given continuous information or just single notification about the target. This made it possible to use the new aerial intercept weapons system in areas with gaps in AD radar coverage, such as the High North. PVO units equipped with the type received the capability to organise concerted action by virtue of the automatic data exchange system; the maximum interception range was as much as 720 km (447 miles) from the base.

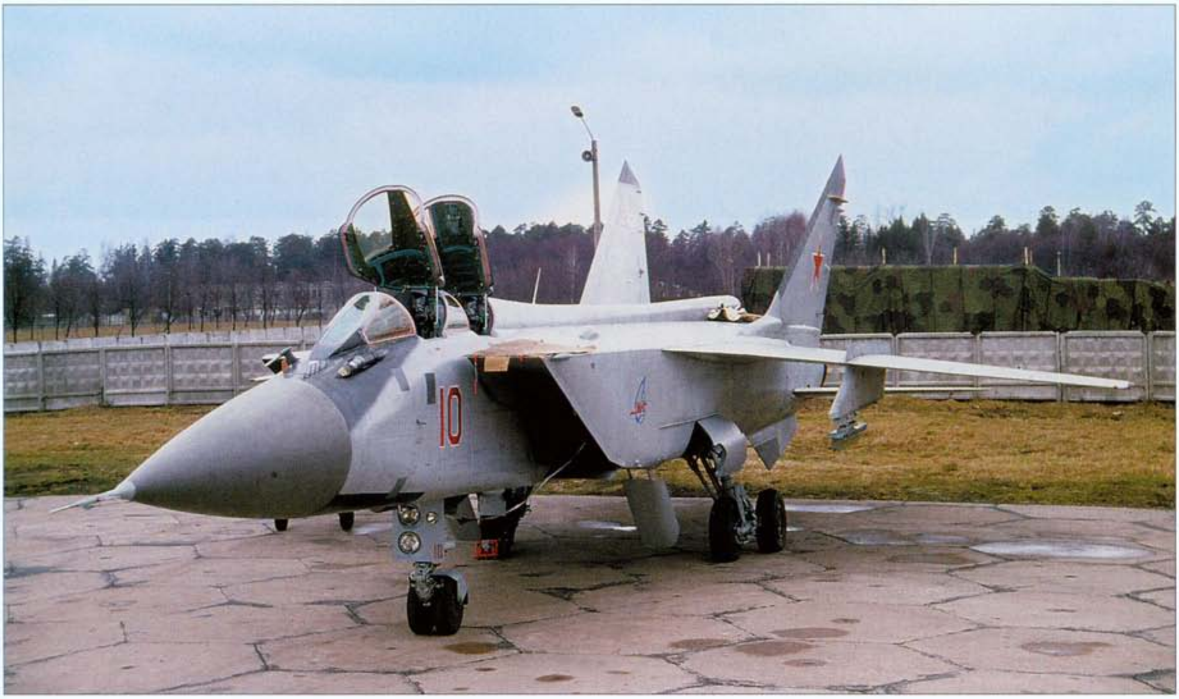
As compared to its predecessor, the MiG-31 was much more fuel-efficient in subsonic cruise; this made the crew feel more confident when returning from a sortie, especially during overwater flights or lengthy missions that took them a long way from home. However, the interceptor also had some serious weaknesses; for instance, range was reduced sharply if one of the engines failed.

The break-up of the Soviet Union and the ensuing political and economic turmoil caused MiG-31 production to be discontinued because the Russian Ministry of Defence had no funds to order more. The production run totalled 505 aircraft, more than 300 of which remained on strength with the Russian Air Force at the turn of the century. Nowadays many of these aircraft have been mothballed due to reorganisations in the Russian air arm (the merger of the formerly separate Air Force and Air Defence Force) which saw many units disbanded – more often than not to cut costs. According to press reports, 43 MiG-31s were taken over by the Kazakh Air Force.

MiG-31 Interceptor with IFR Capability (*Izdeliye* 01DZ)

The MiG-31 was the subject of a constant improvement effort. One of the deficiencies revealed in operational service, especially up North, was its clearly inadequate range. Production interceptors based in Monchegorsk on the Kola Peninsula had to shadow Western reconnaissance and anti-submarine warfare aircraft at up to 1,000 km (620 miles) from their home base, but the PVO wanted more. Even as the joint state acceptance trials were in progress, state commission chairman Air Marshal Yevgeniy Ya. Savitskiy mused that it would be fine to extend the interception range all the way to the US border. This wish later

This MiG-31 coded '10 Red', shown here at Kubinka AB near Moscow, represents the *izdeliye* 01DZ version featuring in-flight refuelling capability. The retracted IFR probe is visible on the port side of the nose ahead of the windshield. Note the Mikoyan OKB badge on the air intake, despite the fact that, at the time, the at the aircraft did not belong to the Mikoyan OKB. ▼



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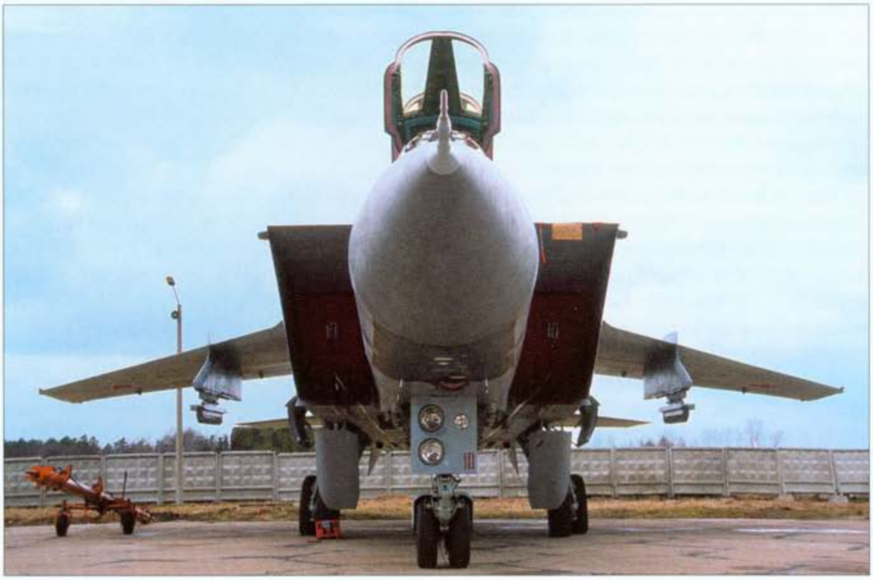
Front view of the same MiG-31. For quick identification on the flight line operational MiG-31s often had the tactical code repeated on the nose gear door. APU-60-2 twin launchers for R-60 short-range AAMs are attached to both wing pylons.



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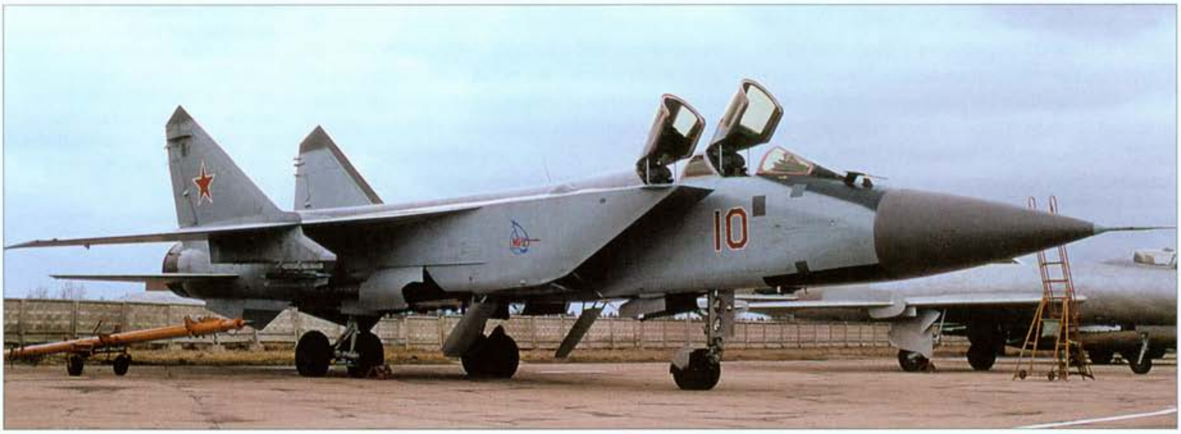
Two more views of MiG-31/*izdeliye* 01DZ '10 Red'. The black area on the underside of the nose immediately aft of the radome is an anti-glare panel preventing disruptions in the operation of the retractable infra-red search & track (IRST) unit.



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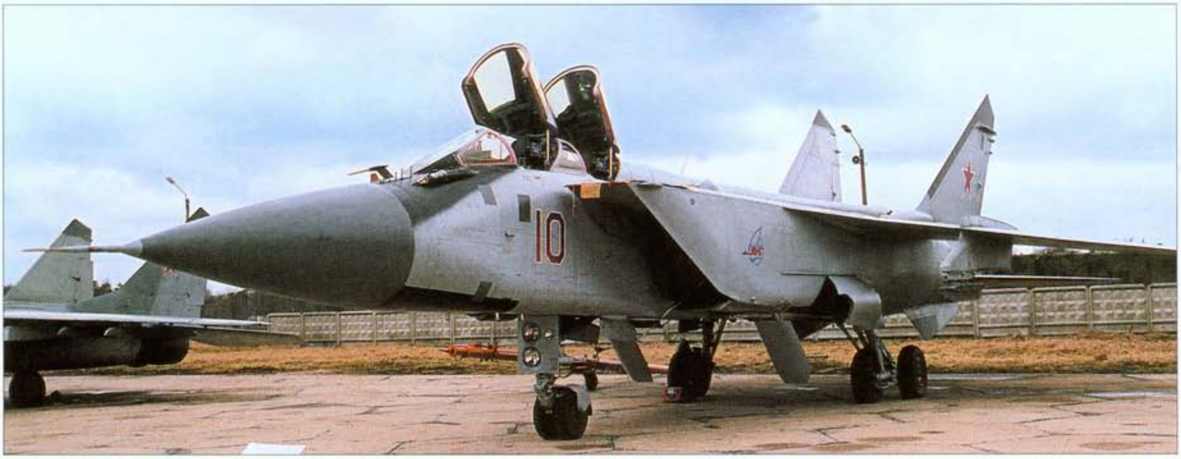

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materialised as a version of the MiG-31 featuring in-flight refuelling(IFR) capability, utilising the probe-and-drogue system.

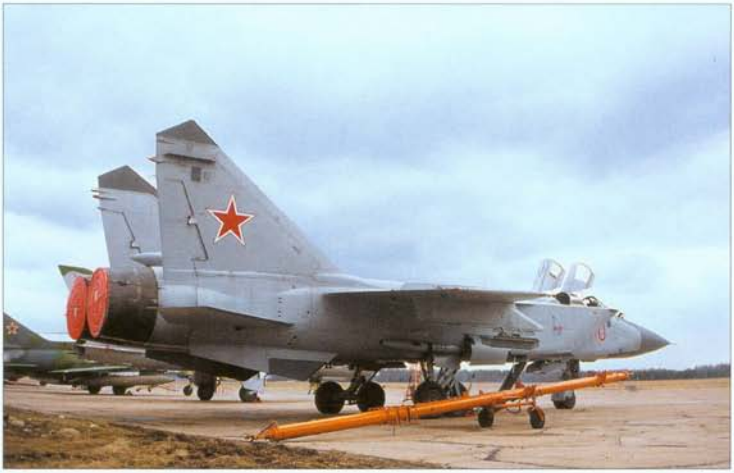
The retractable L-shaped refuelling probe was located ahead of the cockpit windshield, offset to port. It was stowed at all times except during contact with the tanker, disrupting the contours of the aircraft very little and requiring the addition of a very small fairing.

The IFR system underwent lengthy trials on several aircraft, including a pair of one-off modified *Foxbats* – the MiG-25PDZ ('45 Blue') and the MiG-25RBVDZ (coded '68'). The DZ suffix added to the original designations denoted *doza**prah**v**ka*** – refuelling. The Mikoyan OKB experimented with both port and starboard side locations of the probe before settling for the former option.

The first *Foxhound* to feature an IFR probe was MiG-31 f/n 3603 (quite possibly coded '77 Red' and fitted with cine cameras); this was actually a dummy installation, as the probe was not connected to the fuel system and fuel transfer was impossible. The aircraft served for testing the probe actuation mechanism and for 'dry runs' with the refuelling tanker. The two MiG-25 IFR system testbeds had featured a micro-throttle system enabling minute engine power adjustments to facilitate contacts with the tanker's drogue. Initial tests showed that the IFR-capable MiG-31 did not need this system, as the standard throttles allowed contact to be made without any difficulty. Nevertheless, the micro-throttle system was fitted anyway to enhance flight safety and make the pilots fell more comfortable.

V. S. Yegorov was appointed engineer in charge of the tests. The greater part of the test programme was performed by OKB pilots in Zhukovskiy, followed by further testing in Akhtoobinsk at the hands of GNIKI VVS pilots.

The next development aircraft was another Batch 36 MiG-31, '368 Blue' (f/n 3608). This aircraft featured a fully functional IFR probe and fuel transfer system; however, it lacked the system which automatically monitored the quantity of fuel transferred.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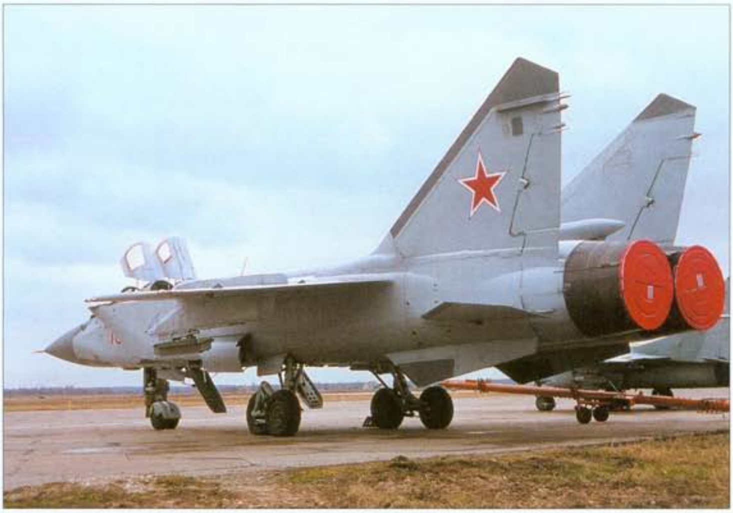
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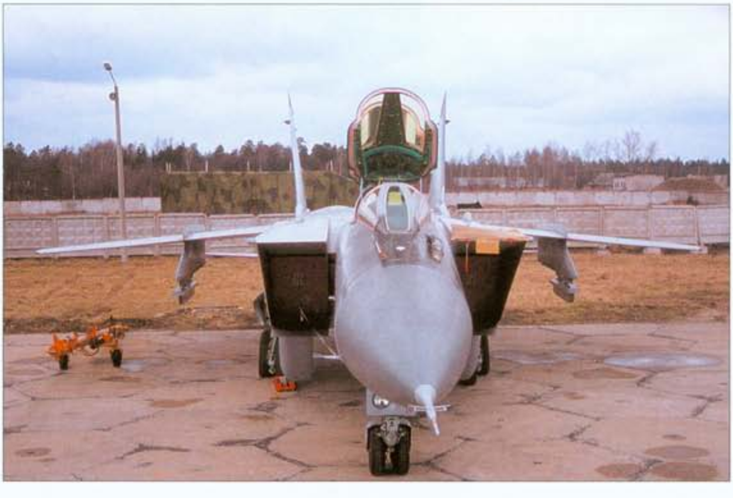
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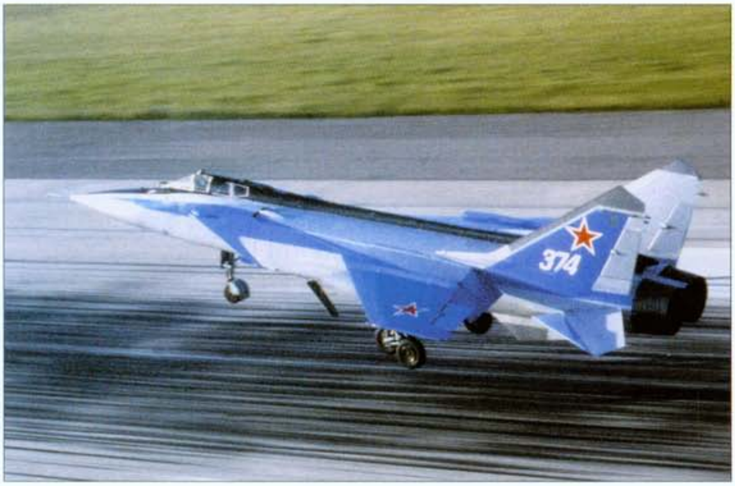
▲ ▲ ▶
Three more aspects of the same aircraft. The IFR-capable *izdeliye* 01DZ retained the original mission avionics of the MiG-31/*izdeliye* 01 which were replaced by a more capable weapons control system on the MiG-31B.



Sergey Skrynnikov

▲ This company-owned IFR-capable MiG-31 received this stylish colour scheme and code '374 White' (c/n N69700121496) for the type's international debut at the 1989 Paris Air Show.

Long-range missions involving in-flight refuelling necessitated the provision of a long-range radio navigation (LORAN) system. Thus the first fully equipped example was MiG-31 '592 Blue' (f/n 5902). The aircraft was fitted with a new fuel metering system and a test programme was held in which both Mikoyan OKB and military test pilots participated. OKB test pilots Roman P. Taskayev and Toktar O. Aubakirov and test navigator Leonid S. Popov bore the brunt of the testing, making ultra-long-range flights in the High North. On 30th July 1987 Taskayev and Popov made the first-ever cross-Polar flight in an interceptor, topping off their fuel tanks twice from an Ilyushin IL-78 tanker; the route took them from the fighter base at Monchegorsk (Murmansk Region) to the North Pole and thence to Anadyr' (Oogol'nyy airport) on the Chukotka Peninsula over areas with few navigation aids and no landmarks. The aircraft was airborne for 6 hours 26 minutes, the pilots using the LORAN system to navigate.

Another notable flight covering a distance in excess of 8,000 km (4,970 miles) was made in autonomous navigation mode with two fuel top-ups and an elapsed time of 8 hours 40 minutes. Two simulated targets were 'intercepted' on that occasion, including one over the North Pole; the aircraft's systems functioned perfectly. The duration of the flight with IFR capability was limited only by the crew's physiological limitations.

In training sorties the IFR-capable MiG-31 intercepted targets with extreme efficiency at distances up to 2,200 km (1,365 miles) from the base. Among other things, the crew of Toktar O. Aubakirov checked the operation of the navigation suite in extreme northern latitudes where various natural magnetic anomalies are present.

At the Gor'kiy aircraft factory the IFR-capable version of the MiG-31 received the product code '*izdeliye* 01DZ' (for *doza***prahv***ka*); strangely enough, the addition of the IFR sys-

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► ANPK MiG chief test pilot Valeriy Menitskiy discusses a test flight he has just completed with ANPK MiG designers at Zhukovskiy. The aircraft in the background is the same MiG-31 '374 White'.

Sergey Skrynnikov

Yefim Gordon

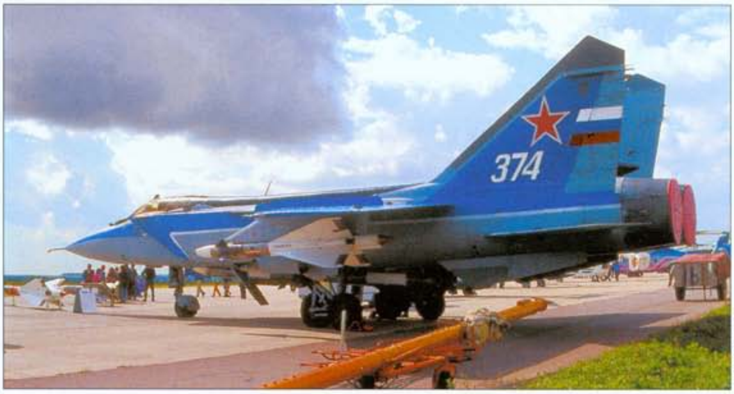
▲
A fine air-to-air of '374 White' taken during a high-altitude flight.

◄
MiG-31 '374 White' was displayed statically and in flight at the MAKS-93 airshow in Zhukovskiy.

When the aircraft appeared again at the MAKS-95 airshow, the colour scheme had been modified by the addition of a Russian flag on the rudders.
▼

tem did not affect the service designation in any way. The new version entered production in 1990, staying in production for a year until it was succeeded by the more refined MiG-31B; the production run was small (about 45 aircraft). Outwardly *izdeliye* 01DZ differed from the initial production version only in having an IFR probe to port, which was quite unobtrusive when stowed.

Flown by Mikoyan CTP Valeriy Ye. Menitskiy, the IFR-capable MiG-31 was displayed many times both in flight and statically at the international airshows at Paris-Le Bourget, Farnborough, Berlin-Schönefeld (ILA) and Zhukovskiy (MAKS).



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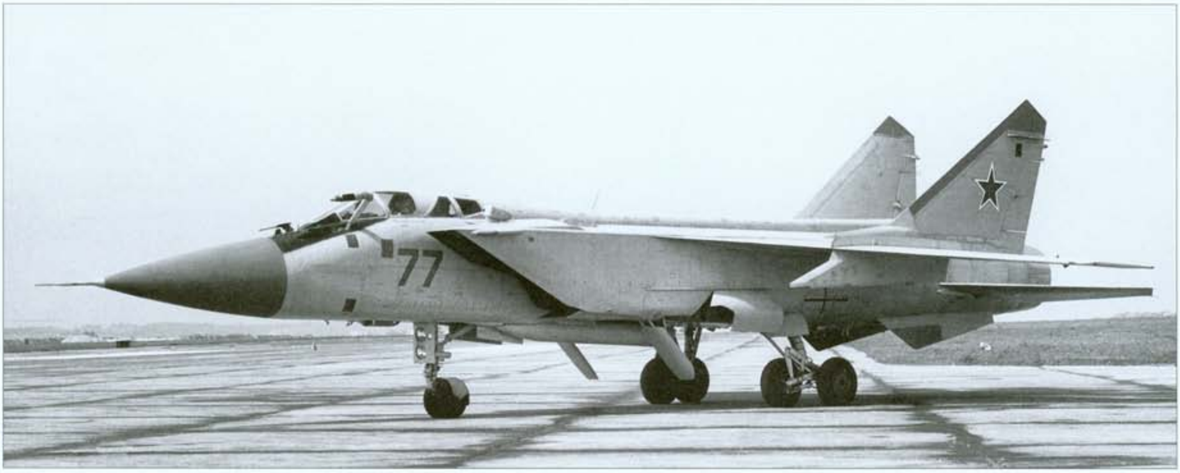

RSK MiG

▲
'77 Red' (possibly f/n 3603) was operated by the Mikoyan OKB as an IFR system testbed. Note the unobtrusive photo calibration cross aft of the port main gear unit.

►
Front view of MiG-31 '77 Red' with the probe deployed. Note the cine camera 'egg' installed on top of the port air intake to capture the refuelling sequence; it is also visible in the photos above and below.

Another view of the same aircraft, showing the deployed IFR probe. The object on the port forward fuselage hardpoint may be a test equipment pod.
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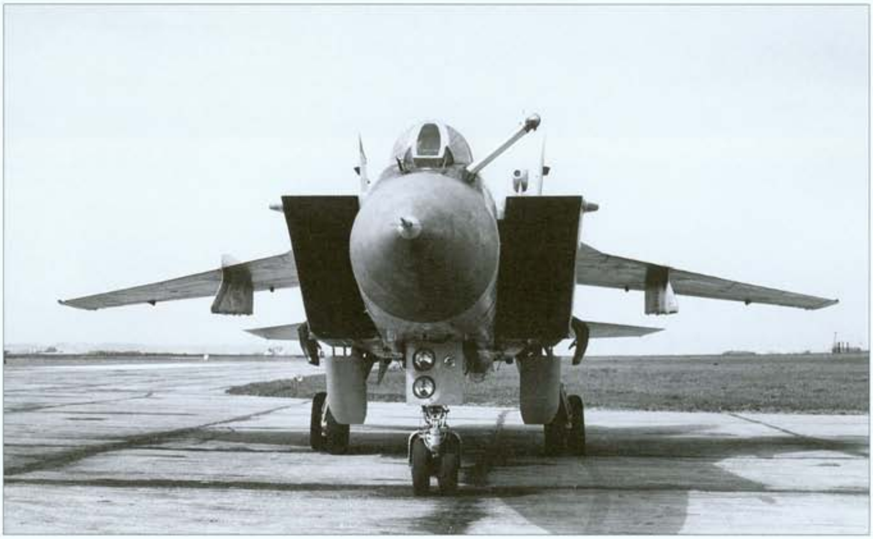
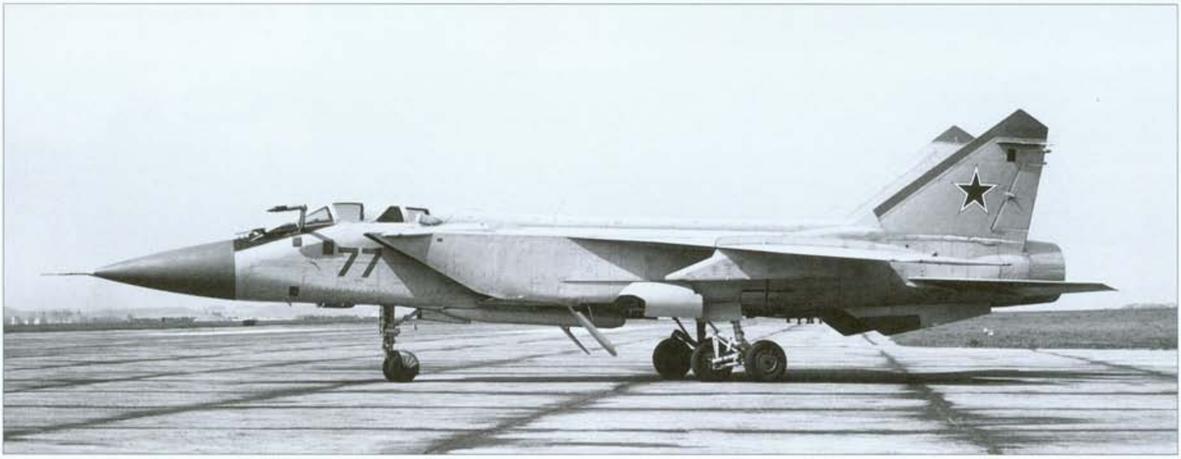


RSK MiG



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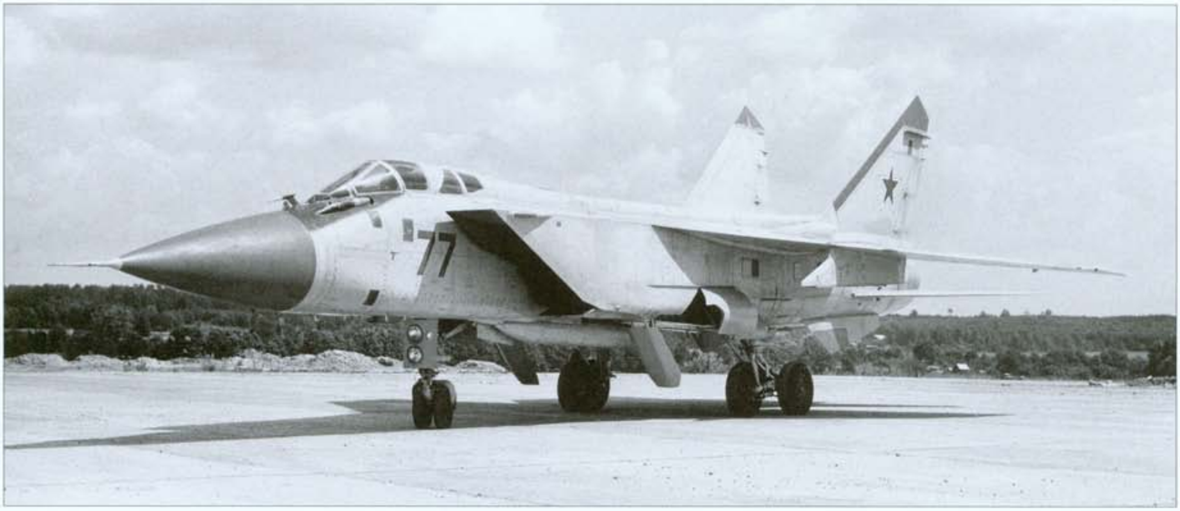


RSK MiG

▲ **The same aircraft with the IFR probe in stowed position. The pod on the port forward fuselage hardpoint looks like an R-33 missile minus fins and rudders.**

MiG-31B Interceptor (*Izdeliye* 01B, *Izdeliye* 12)

Apart from extending the MiG-31's range, the Mikoyan OKB and its partners consistently worked on improving the interceptor's armament. The need to do so was due in no small degree to leaks of sensitive information about the MiG-31 to the West. In 1985 one A. Tolkachov, a spy working for one of the Western intelligence agencies, was arrested in Moscow; the investigators found out that he had passed valuable information on the specifications of the MiG-31's avionics and armament to his Western 'employers'. Tolkachov's actions were even more damaging than Viktor Belenko's notorious defection to Japan in a MiG-25P in 1976. As a result, the design bureaux had to step up their efforts to equip the production MiG-31 with a new weapons system.

The work went ahead in two directions. Firstly, the Mikoyan OKB and its subcontractors worked on the radically upgraded MiG-31M featuring an all-new weapons system; however, this aircraft would take a lot of time to test and perfect, to say nothing of series production. Hence the designers made an attempt to boost the combat potential of the interceptor then in production.

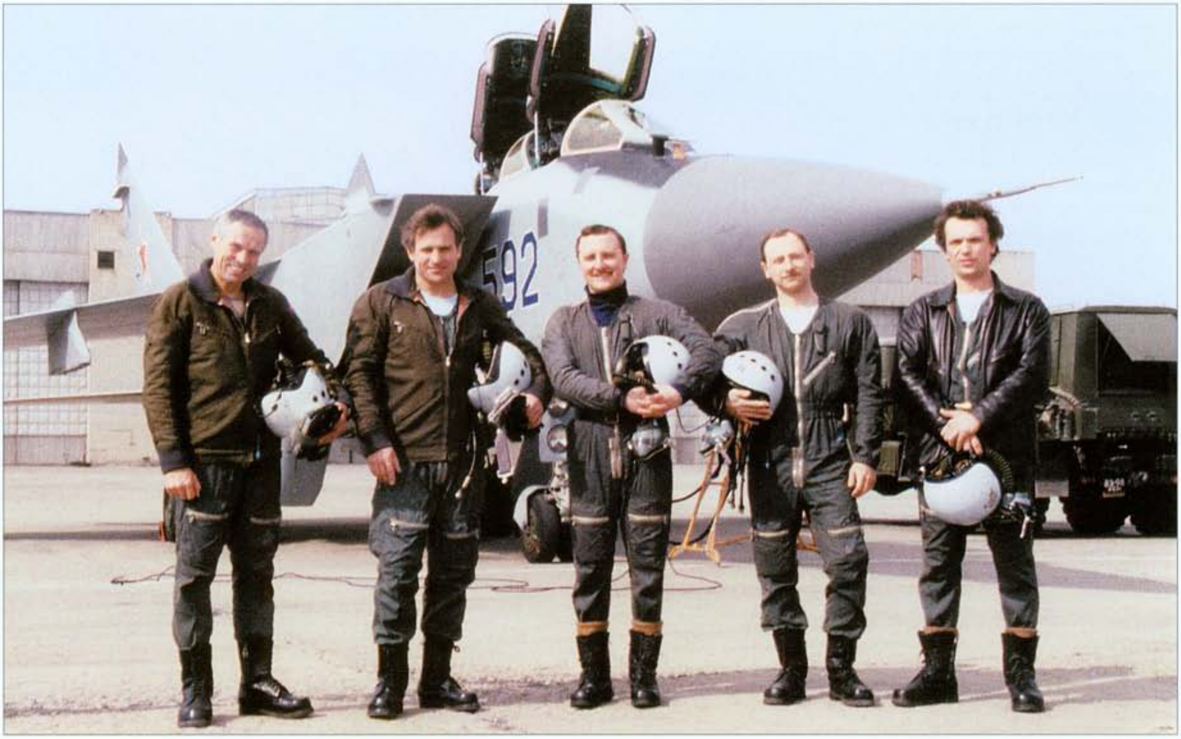
Additionally, a sizeable list of recommendations for upgrading and refining the MiG-31 were made, proceeding from the results of the state acceptance trials. These recommendations were combined with a number of new features developed by the Mikoyan OKB and the Gor'kiy aircraft factory in the 1980s to form an upgrade package turning the basic MiG-31 *sans suffixe* into a new version designated MiG-31B (curiously, there never was a MiG-31A).

Yefim Gordon

◄ **'77 Red' in its latter days, sitting forlornly at Zhukovskiy in non-airworthy condition around 1998. The large shed is one of many used to protect sensitive new hardware from being seen by US surveillance satellites.**

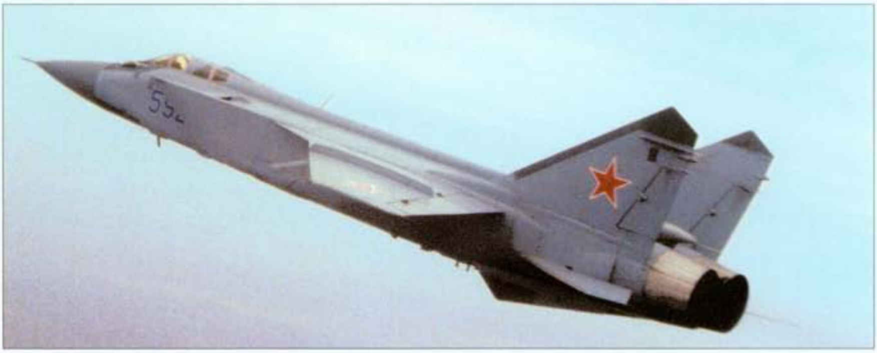
RSK MiG

RSK MiG



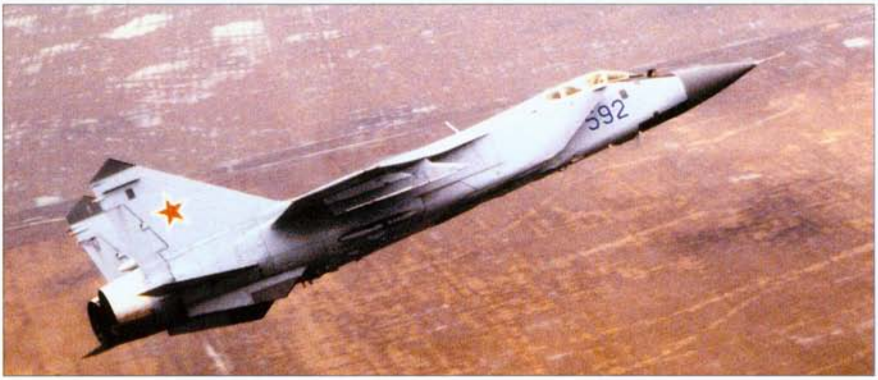
Sergey Skrynnikov

▲
ANPK MiG flight crews in front of a MiG-31B prototype at the GNIKI VVS flight test facility in Akhtoobinsk. Left to right: navigator Leonid S. Popov, test pilot Valeriy Ye. Menitskiy, test pilot Aleksandr Yu. Garnayev, test pilot Sergey P. Khazov and test pilot Pavel N. Vlasov.



Sergey Skrynnikov

►
'592 Blue' (f/n 5902), one of the MiG-31B prototypes, on a routine test flight.



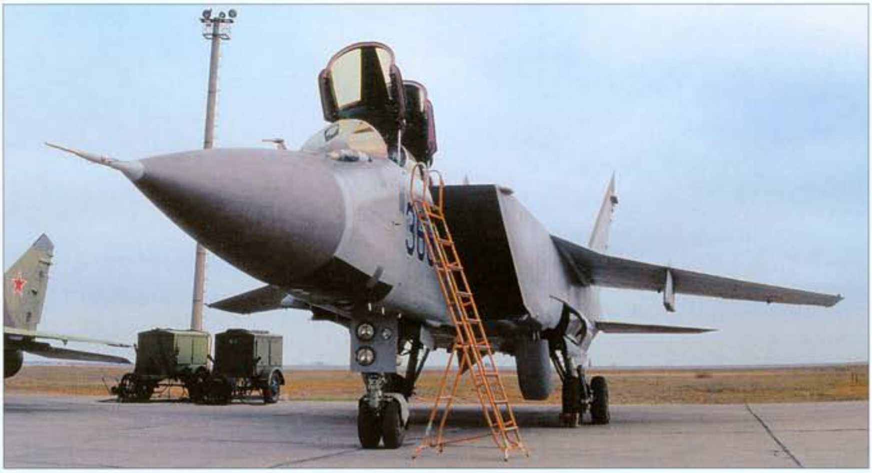
Sergey Skrynnikov

►
Another air-to-air of '592 Blue', showing the outer wing pylons used for R-60 short-range AAMs.

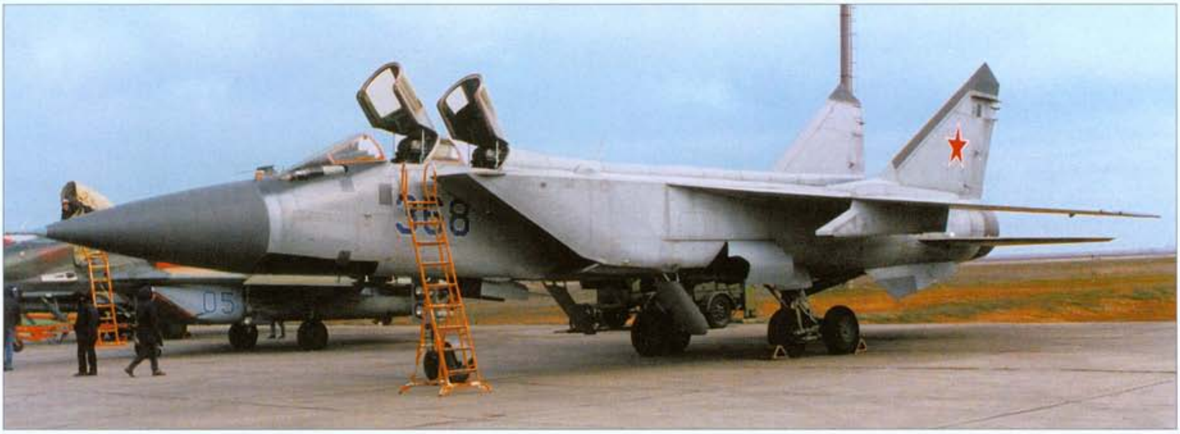
◄◄
The views on the opposite page show the same MiG-31B prototype in almost fully armed condition. Dummy R-40R radar-homing missiles (used by the MiG-25 but NOT the MiG-31!) are carried on the inner wing pylons. The red/white chequered R-33 in the port forward ventral position is an instrumented test round.

▶
Outwardly '368 Blue' (f/n 3608) appears to be a MiG-31B. Actually, however, it is a probe-equipped MiG-31 used by GNIKI VVS for perfecting the *Foxhound*'s in-flight refuelling system; it lacks some of the equipment the MiG-31B should have (see pages 26 and 27).
▼

This three-quarters rear view of '368 Blue' shows the characteristic 'solid' nozzle shrouds of the D30F-6S engines powering production MiG-31s (compare with the photograph on page 5).
▼▼



Yefim Gordon



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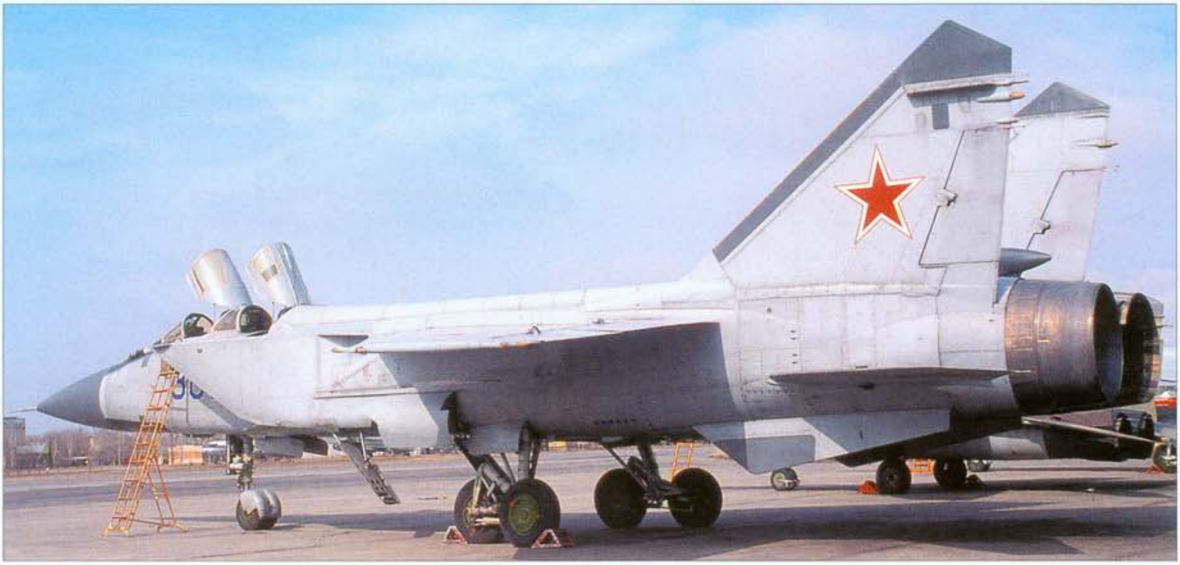

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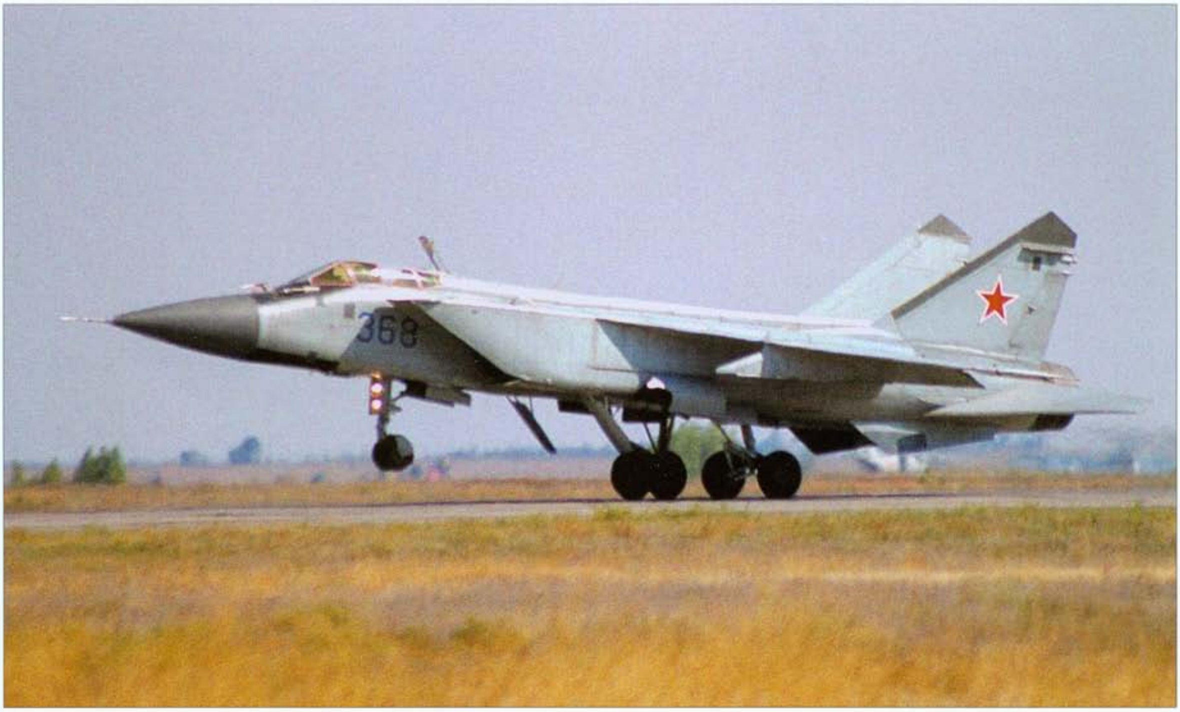
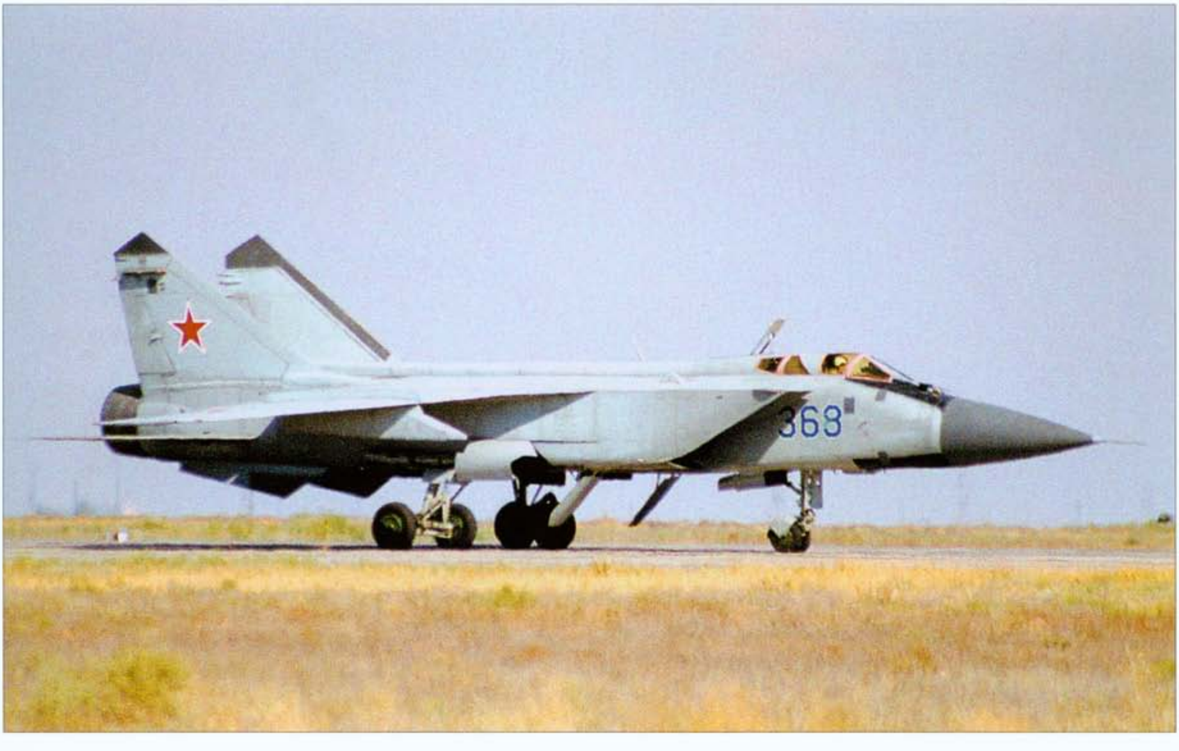


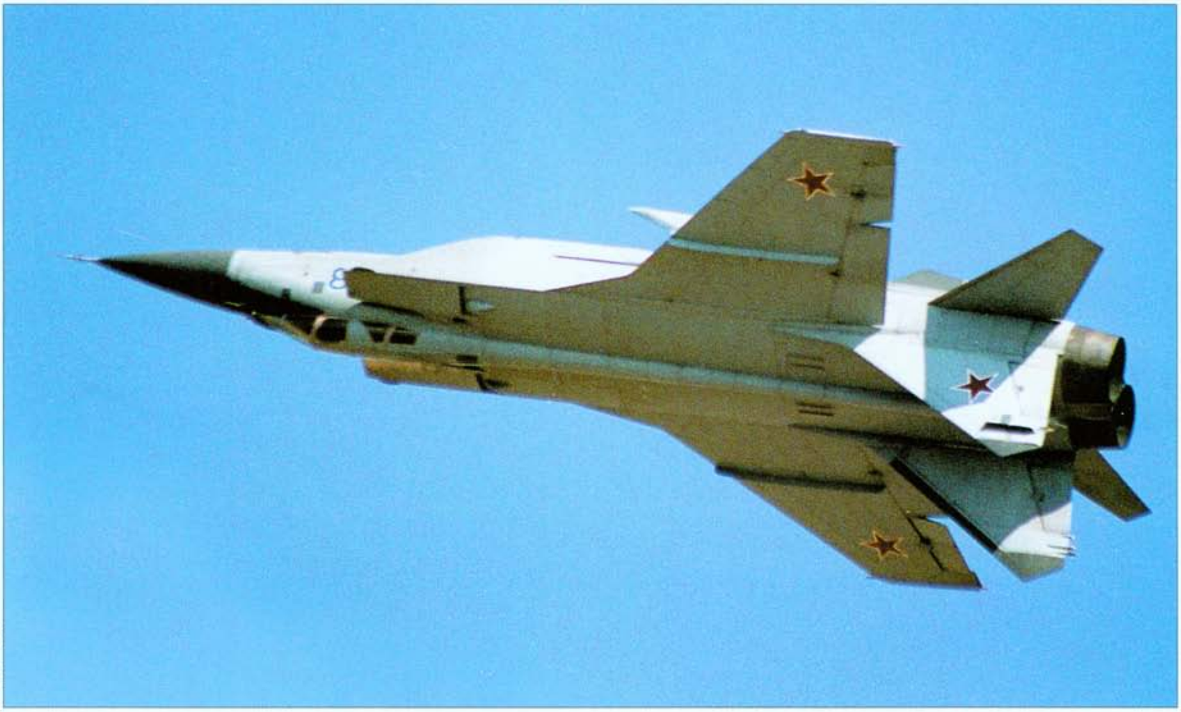
Sergey Sergeyev

▲ MiG-31 '368 Blue' takes off on a demonstration flight.

▼ Another view of '368 Blue' as it completes its landing run.

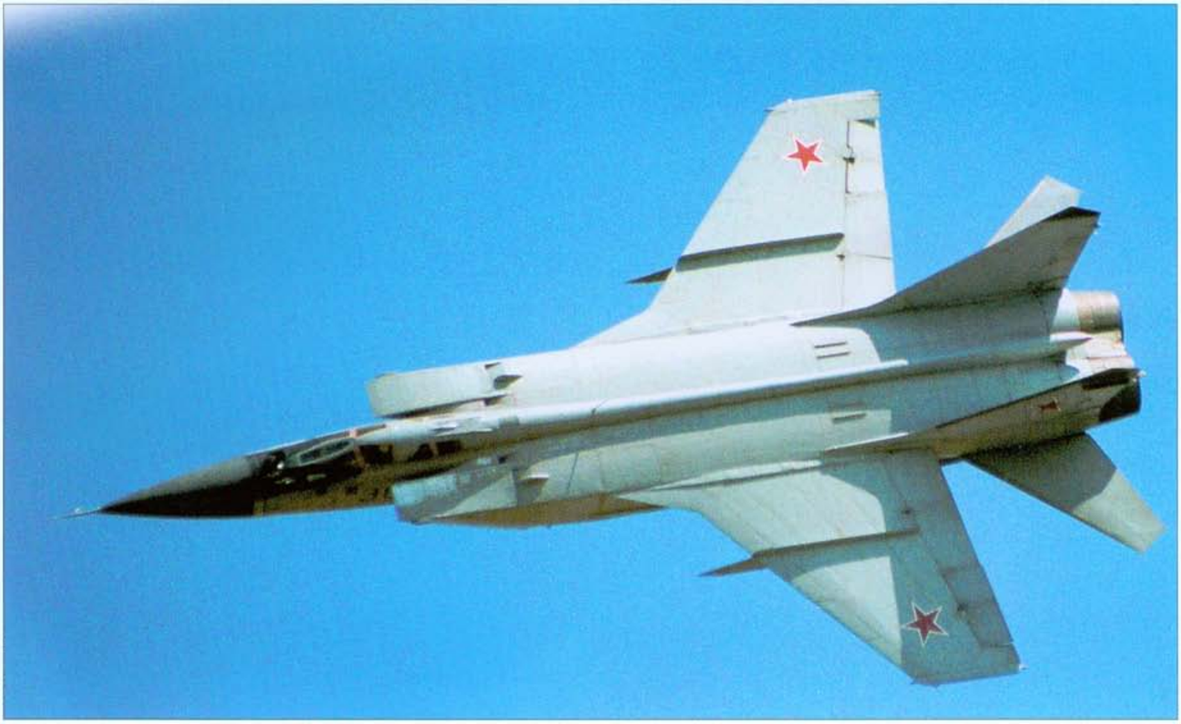


Sergey Sergeyev



Sergey Sergeyev

Of course, the heavy MiG-31 lacks the agility of tactical fighters such as the F-16, but it is still capable of aerobatics, as illustrated here by '368 Blue' performing a barrel roll. The wing LERXes improve the aircraft's low-speed agility and handling.



Sergey Sergeyev

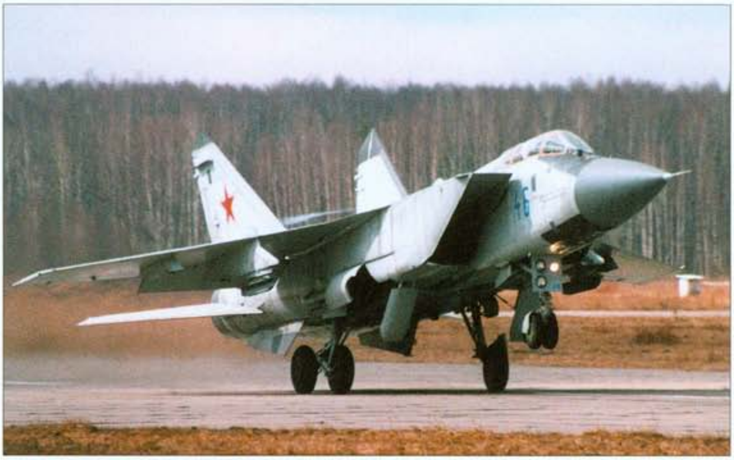
The principal changes introduced on the MiG-31B were as follows:

- the upgraded RP-31A weapons control system (alias Zaslon-A or S-800A);
- the use of improved R-33S long-range AAMs featuring a longer 'kill' range and provisions for a nuclear warhead (!);
- the use of alternative additional weapons (IR-homing missiles) carried on wing pylons – either two R-40T/R-40TD medium-range AAMs or four R-60M short-range AAMs on paired rails;
- the addition of an IFR system as used on the MiG-31/*izdeliye* 01DZ;
- the provision of new tactical information and weapons control modes ('downloading' target information to ground command posts or other aircraft – not necessarily sister ships, 'tandem guidance' in which another aircraft's fire control radar is used for guiding the interceptor's missile etc.);
- an upgraded navigation computer compatible with LORAN and satellite navigation systems (including A-723 Kvitok-1 LORAN) to enhance navigation accuracy in high latitudes;
- more capable ECM systems to offset the progress of Western radar technology;
- an *Ekrahn* (Screen) common built-in test equipment/crew alerting system (BITE/CAS) replacing the existing RIU system. The Ekran system was developed by the Elektronpribor (= electronic device) Scientific & Production Complex in Kiev, the Ukraine, and produced by the Pribor Scientific & Production Enterprise in Kursk, Russia.

The aircraft's control system was also updated. GNIKI VVS test pilot Col. Vladimir Shushunov, Hero of Russia, made a major contribution in this area.

The MiG-31B (*izdeliye* 01B) superseded the MiG-31 (*izdeliye* 01DZ), to which it was outwardly all but identical, on the production line in 1990. The product code was later changed to *izdeliye* 12 and the factory code in the c/n was altered at the same time; thus, a well-known MiG-31B demonstrator belonging to the Mikoyan OKB ('903 White') is c/n N38401208786.

Concurrently the Mikoyan OKB and the Soviet Air Force launched a mid-life update (MLU) programme to upgrade existing MiG-31s *sans suffixe* to MiG-31B standard. A MiG-31B coded '068 Blue' – one of several development aircraft operated by GNIKI VVS – was demonstrated to the press in the spring of 1992 when the then Russian Air Force Commander-in-Chief Pyotr S. Deynekin paid a visit to the institute.


Vyacheslav Martyniuk

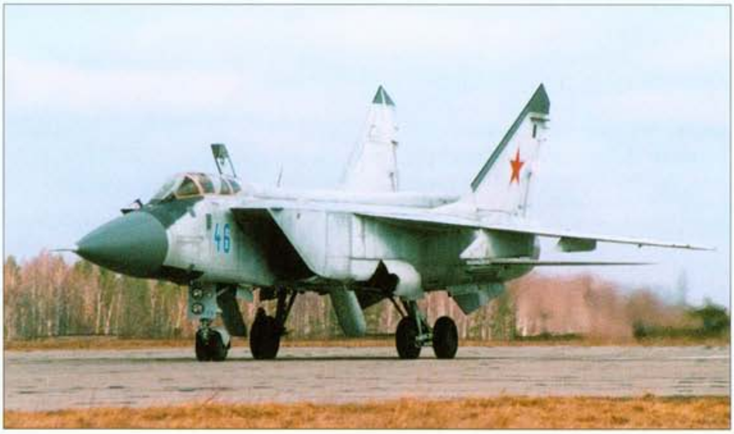
▲ **MiG-31BS '46 Blue' is seen here seconds before becoming airborne at Savasleyka AB.**

MiG-31BS interceptor (*Izdeliye* 01BS)

As noted above, in addition to manufacturing new MiG-31Bs the Gor'kiy (or rather Nizhniy Novgorod) 'Sokol' aircraft factory performed upgrade work on operational MiG-31s *sans suffixe*. These aircraft had the same avionics/weapons fit as the new-build *izdeliye* 01B/*izdeliye* 12 but lacked the latter version's refuelling probe, which could only be fitted to new aircraft with a revised forward fuselage structure. Thus the capabilities of existing MiG-31s were enhanced at minimum cost.

By analogy with the MiG-25PDS, which was a MiG-25P upgraded to MiG-25PD standard, the updated *Foxhounds* were designated MiG-31BS, the S denoting *stroye**voy*** (in this case, operational) to distinguish such aircraft from new-build 'Bs. Outwardly the updated aircraft was unchanged; you had to look into the cockpits to tell it from the original version.

Another view of '46 Blue' after landing, showing the absence of the IFR probe on the MiG-31BS and the deployed forward view periscope in the rear cockpit. ▼


Vyacheslav Martyniuk

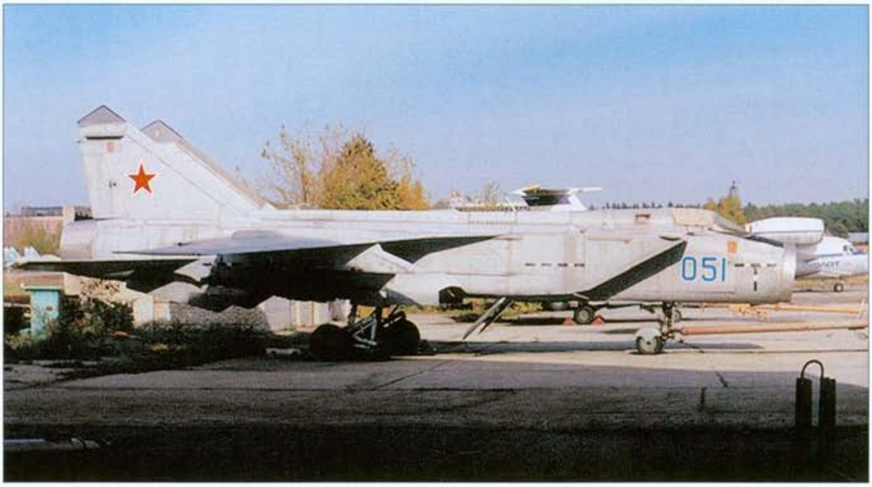
MiG-31/Sokol Factory Upgrade Demonstrator

Building on the experience gained with the MiG-25, which was fairly easy to build and maintain, the 'Sokol' plant's Chief Designer Ye. I. Mindrov drew up a list of measures aimed at cutting the MiG-31's structural weight, reducing the aircraft's manufacturing labour intensity, increasing the internal fuel capacity and improving the manufacturing and maintenance efficiency. In so doing he enlisted the support of A. N. Gherashchenko (Director of plant No.21) and Mikoyan OKB General Designer Rostislav A. Belyakov.

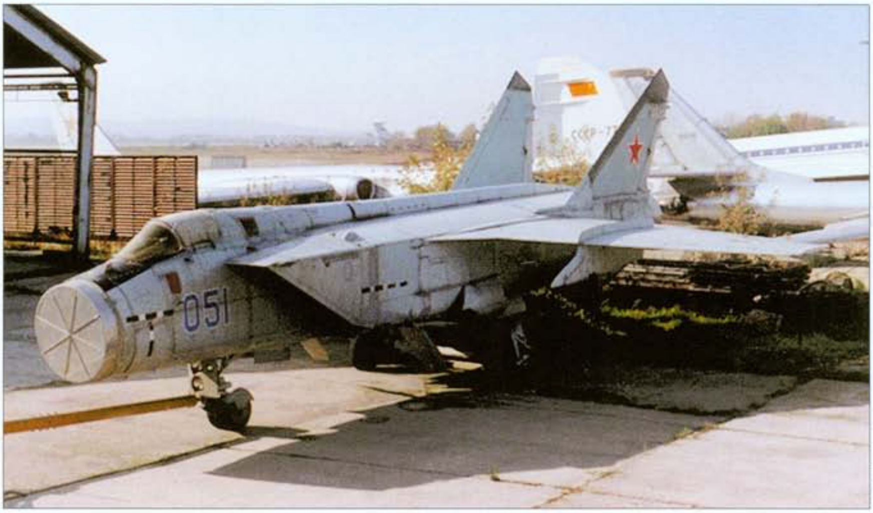
In support of these measures MAP and the Air Force signed a joint resolution in June 1978 earmarking MiG-31 c/n N60700107607 (f/n 0503) for conversion; they also endorsed a document called 'Programme of measures to improve the manufacturing and maintenance efficiency, increase the reliability, prolong the service life and reduce the structural weight of *izdeliye* 01'.

Coded '503 Blue', the aircraft was rather different from stock production MiG-31s. The main differences included a wraparound frameless windscreen, the lack of dorsal blow-in doors on the air intake trunks, greater internal tankage (the Nos 1/2 and 5/6 fuselage tanks were merged), a new brake parachute fairing, additional centreline hardpoints for semi-recessed missile carriage and so on.

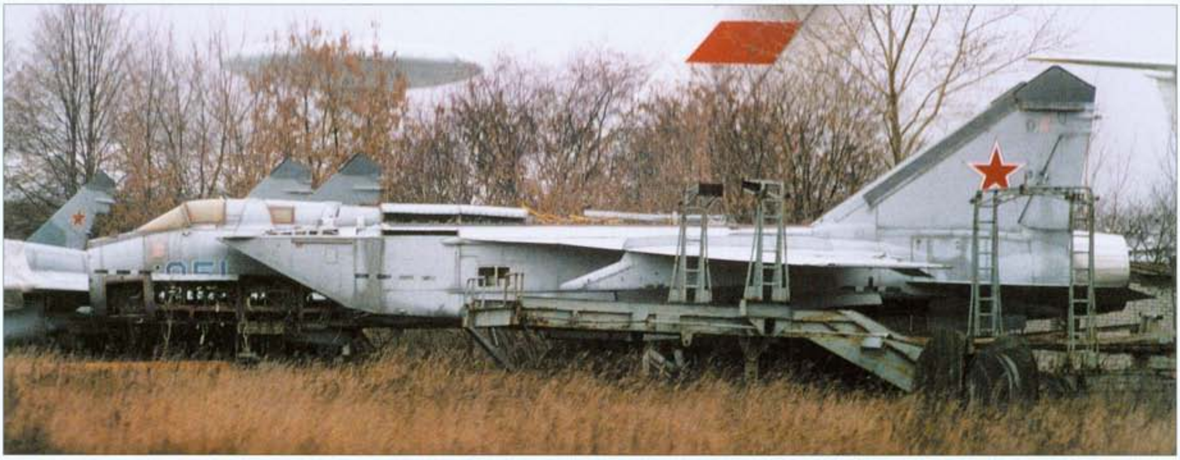
The design documents for the upgrading of MiG-31 '503 Blue' were competed in 1980. The conversion took place at the 'Sokol' factory's prototype construction shop, and on


Via Yefim Gordon

No, this MiG-31 does NOT have a nose air intake with a conical centrebody; quite simply, the radome is removed and the nose of another fighter is visible beyond! Still, '051 Blue' is indeed highly unusual. Though it pretends to be the first prototype MiG-31M, it is neither fish nor fowl, being a regular MiG-31 airframe (ex-'503 Blue') extensively modified for testing some features of the radically different MiG-31M. It is seen here at Zhukovskiy in the mid-1990s after being withdrawn from use.


Via Yefim Gordon

Another view of the retired '051 Blue', still substantially intact, showing the metal cover replacing the removed radome (that's what looks like a 'highly polished air intake lip' in the upper photo). Note the one-piece frameless windshield, the fuselage spine which is a cross-breed between that of the MiG-31 and the MiG-31M, the retention of the standard nose gear with a forward door segment incorporating the landing/taxi lights, and the photo calibration markings.



Via Yefim Gordon

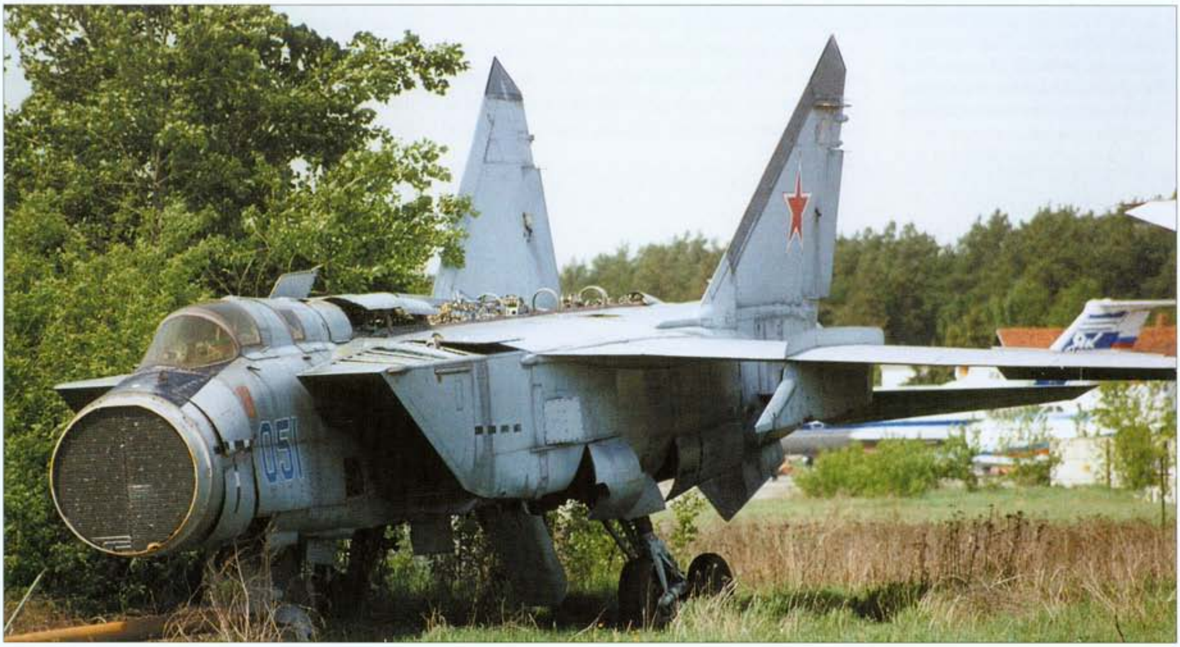
▲
The condition of the 'hybrid prototype MiG-31M' deteriorated steadily during the years of dereliction.

29th December 1983 Mikoyan CTP Aleksandr V. Fedotov finally made the first flight in this aircraft from Sormovo airfield. Yet the head office in Moscow decide that the conversion offered no major advantages over the standard aircraft; besides, '503 Blue' suffered from several apparently insurmountable problems, including a disadvantageous CG position. Thus, while many of the new features did find their way into production, no more aircraft were built to this standard. However, the aircraft became a stepping stone towards the MiG-31M and was subsequently used for test and research purposes.

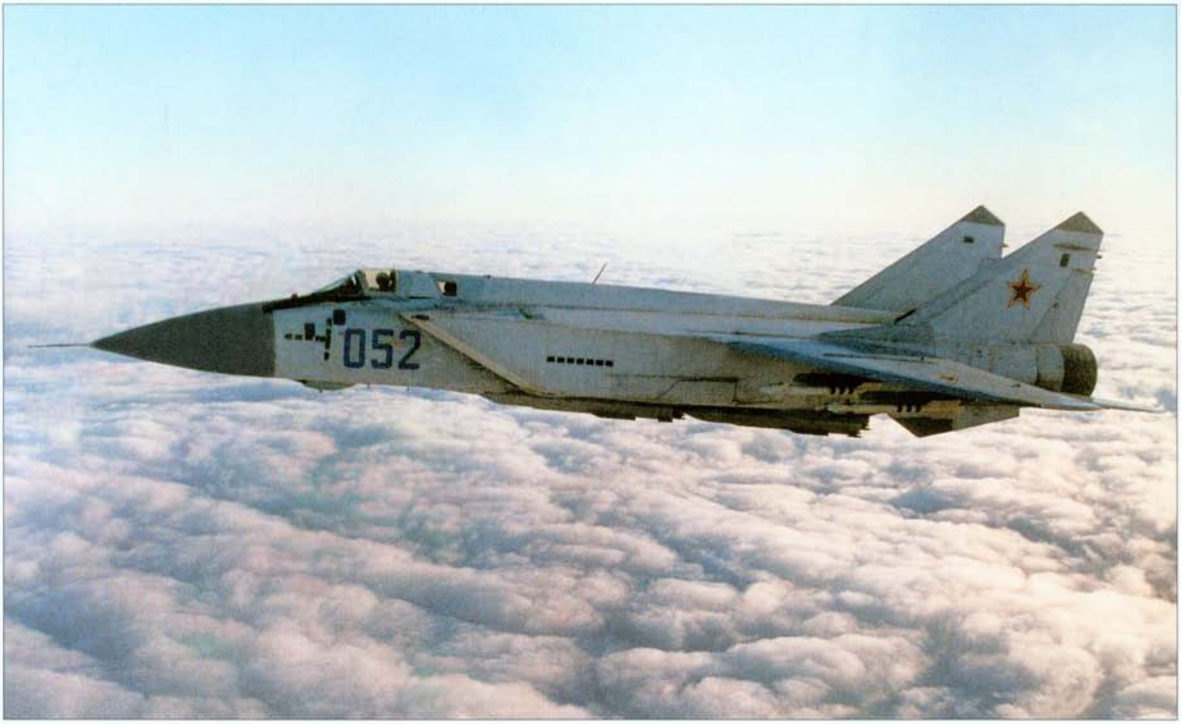
MiG-31M Experimental Interceptor (*Izdeliye* 05)

Development of the much-improved MiG-31M (*moderni**zee**rovannyy* – updated) began in 1983 pursuant to a joint directive issued by the Communist Party Central Committee and the Council of Ministers. This document ordered the Mikoyan OKB to develop an aerial intercept weapons system featuring new ultra-long-range AAMs (then under development at the Vympel Machinery Design Bureau) and new medium-range AAMs. In addition to packing a greater punch, the aircraft was to feature a more advanced avionics suite.

This view of the dumped '051 Blue' shows the phased-array radar antenna with the concealing cover gone.
▼



Yefim Gordon


RSK MiG

▲ This striking shot shows '052 Blue', the first true prototype of the MiG-31M. The much thicker nose and fatter spine are readily apparent. So are the redesigned cockpit canopy, the altered fins featuring identical (and smaller) dielectric portions, the new R-37 long-range AAMs carried under the fuselage and the new wing pylons (the latter carry dummy R-73 short-range AAMs in this case). This aircraft was ultimately destroyed in a crash.

Known in house as *izdeliye* 05, the MiG-31M was intended for BVR combat at extreme ranges and for controlling a large group of earlier-model interceptors. It differed from the MiG-31B mainly in the following aspects:

- a new RP-31M (Zaslon-M) weapons control system was installed, offering significantly longer target acquisition range and a greater number of targets detected and tracked;
- new armament consisting of six new R-37 AAMs having longer range as compared to the R-33/R-33S, supplemented by R-77 (RVV-AE) medium-range AAMs, was integrated. Production R-33S missiles could be carried instead of R-37s; in that case the interceptor's performance would be markedly reduced, but even so it would be higher than the MiG-31B's;
- satellite navigation equipment was added;
- the aircraft was powered by upgraded D30F-6M engines;
- the interior of the WSO's cockpit was revised;
- internal fuel capacity was increased and a new IFR system was provided, with a retractable probe on the starboard side;
- new ESM/ECM equipment forming a united defensive avionics suite was installed and provision was made for active jammers.

The new RP-31M (Zaslon-M) WCS was built around a radar featuring a new phased array of larger diameter (1.4 m/4 ft 7$^1/_8$ in). The principal armament comprised six R-37 missiles having ultra-long range (up to 300 km/186 miles). The capabilities of the Zaslon-M WCS were 1.5-2 times higher as compared to the potential of the production MiG-31s. Zaslon WCS Target acquisition range was increased to 360 km (223 miles) and 'kill' range to 200-230 km (124-142 miles); the number of targets tracked simultaneously rose to 24, six of which could be attacked at a time. The MiG-31M also featured a new opto-electronic targeting system comprising a new IRST and a laser rangefinder.

The new missiles created by NPO Vympel (Pennant) were not only markedly superior to the R-33 in performance but also utilised a completely different control system (they were statically unstable, which helped enhance their agility). Active radar homing was used at the terminal guidance phase. Like the R-33s, the R-37s were semi-recessed in the fuselage underside but located closer together (in two rows of three). In high gross weight configuration the six R-37s were augmented by four R-77 highly agile medium-range AAMs on underwing pylons; these had a maximum 'kill' range of 100 km (62 miles) and a manoeuvring G limit of 12. Since the MiG-31M was intended for engaging the targets at extremely long range, the designers decided to dispense with the cannon.

The installation of the new weapons and WCS led to a massive redesign of the airframe. Thus, the greater diameter of the radar antenna necessitated an appropriate increase in the diameter of the forward fuselage and the radome; this, in turn, required the extreme nose to be angled 7° down in order to ensure adequate cockpit visibility. The canopies of both cockpits were redesigned; the forward cockpit featured a one-piece wraparound windshield, which again improved the pilot's field of view. Since the WSO's cockpit was no longer fitted with a second set of flight controls, the rear canopy windows were reduced in size and reshaped, and the forward vision periscope was deleted. The fuselage spine running from the cockpits to the brake parachute container was much fatter, housing an additional 300 litres (66 Imp gal) of fuel. All-up weight was increased to 52 tons (114,640 lb), necessitating the installation of uprated D30F-6M engines.

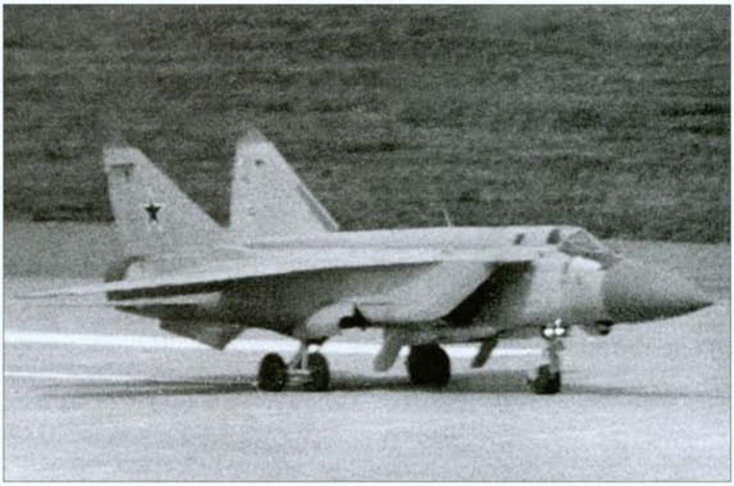
Changes were made to the wings and tail surfaces. The wing LERXes were enlarged, receiving a curved leading edge; provisions were made for installing cigar-shaped active ECM pods at the wingtips. The shape of the vertical tails, including the fin fillets, was also revised.

Many systems and equipment items were designed anew; thus the refuelling probe was relocated from port to starboard, the greater diameter of the nose allowing it to be stowed completely. Much of the avionics complement was new; for instance, the WSO's workstation featured four new-generation rectangular displays. The retractable IRST pod on the forward fuselage underside of the MiG-31 *sans suffixe* and MiG-31B/BS gave place to a new integrated IRST/LR system with a pod that protruded rather more when retracted. Interestingly, the increase in all-up weight caused virtually no deterioration in the anticipated top speed and service ceiling as compared to the 'first-generation' MiG-31.

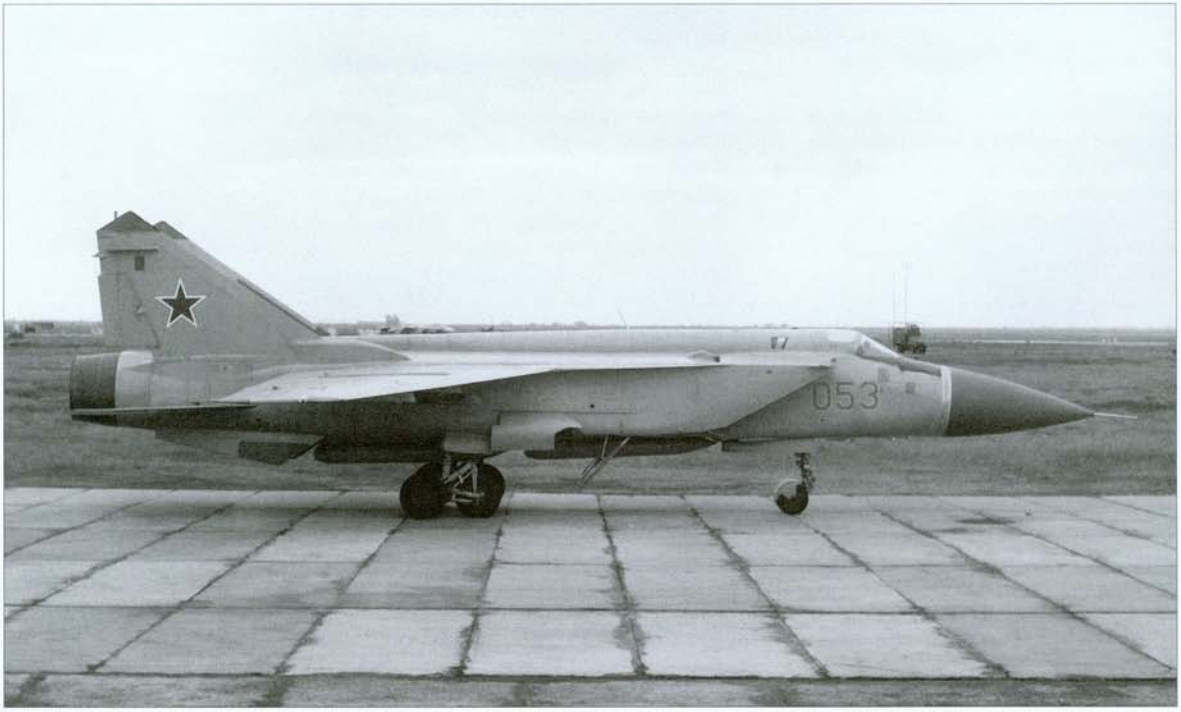
The PVO command showed a strong interest in the new interceptor whose capabilities exceeded by far all previous versions of the *Foxhound*. Therefore it was decided to build a pre-production batch of MiG-31Ms at the Gor'kiy aircraft factory for use in the trials programme. The first example built (c/n 050101 – *izdeliye* 05, Batch 01, first aircraft in the batch) was the static test airframe known as '*izdeliye* 05 stat'. As construction of the prototypes progressed, it transpired that there was a complete surplus radar; it made sense to install it in an aircraft for test purposes. Accordingly it was decided to convert the aforementioned MiG-31 '503 Blue' which had had already been extensively modified at the initiative of the Gor'kiy factory (the 'pre-M'). A new forward fuselage section was constructed at MMZ No.155 (the OKB's experimental plant) in Moscow and mated with the 'beheaded' fuselage of '503 Blue'; appropriate changes were made to the fuselage spine and other elements. The result was a unique hybrid which, though it superficially resembled a MiG-31M and featured the same radar, differed from the 'M – and from the production MiG-31 *sans suffixe*/MiG-31B, for that matter – in many ways. For instance, the wing LERXes were of the old type (with a straight leading edge), while the fin fillets were virtually non-existent. This development aircraft was recoded '051 Blue', which very probably meant '*izdeliye* 05, flying prototype No.1'.

Adding weight to the above theory, '051 Blue' converted in Moscow commenced flight tests ahead of the new-build examples manufactured in Gor'kiy. The maiden flight took place on 21st December 1985 with pilot Boris A. Orlov and WSO Leonid S. Popov at the controls. Yet, as mentioned above, this aircraft was neither fish nor fowl; the first real MiG-31M was '052 Blue' which took off a year later, on

One of the MiG-31M prototypes taxies past the control tower at Zhukovskiy in the late 1980s, showing the IRST fairing under the nose and the different nose gear door design (the landing/taxi lights are attached to the nose gear oleo). Compared to the 'first-generation' MiG-31, the MiG-31M appears extraordinarily well-fed. ▼



Yefim Gordon



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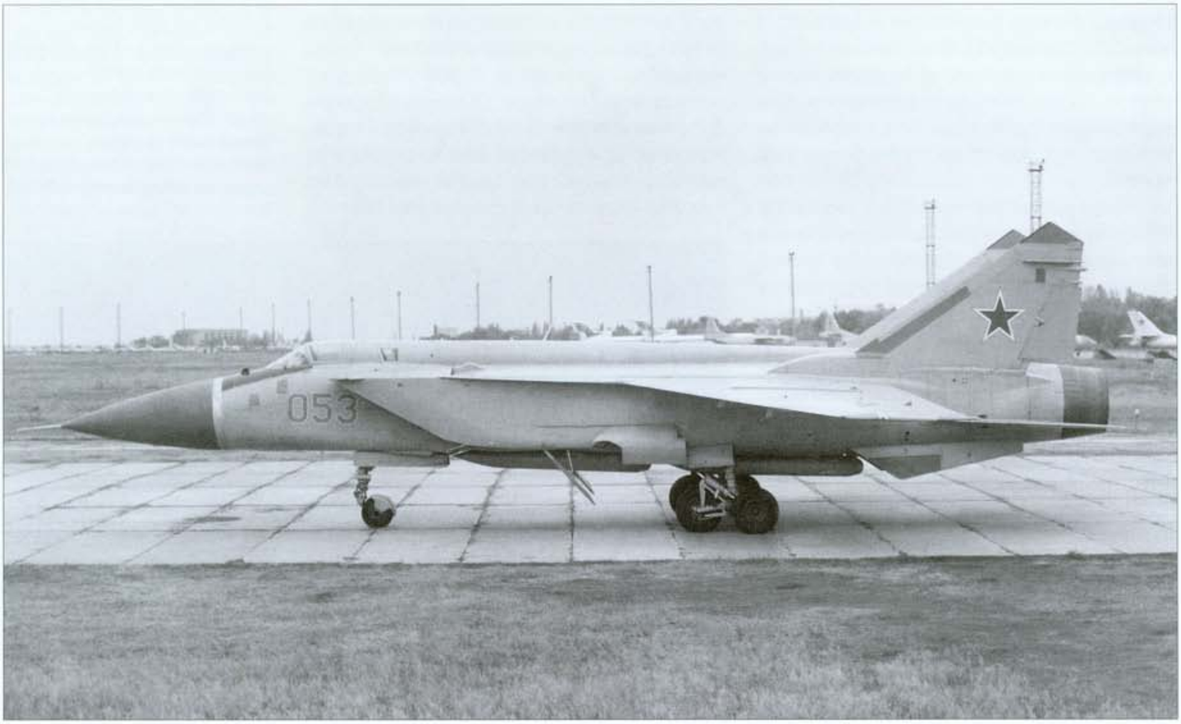
'053 Blue', the second true prototype MiG-31M, resting between test missions at GNIKI VVS (Vladimirovka AB, Akhtoobinsk). Note the IFR probe relocated to starboard, the lack of the cannon, the dielectric port fin leading edge, the wingtip ECM fairings and the characteristically curved fin root fillets. ▼▲▶



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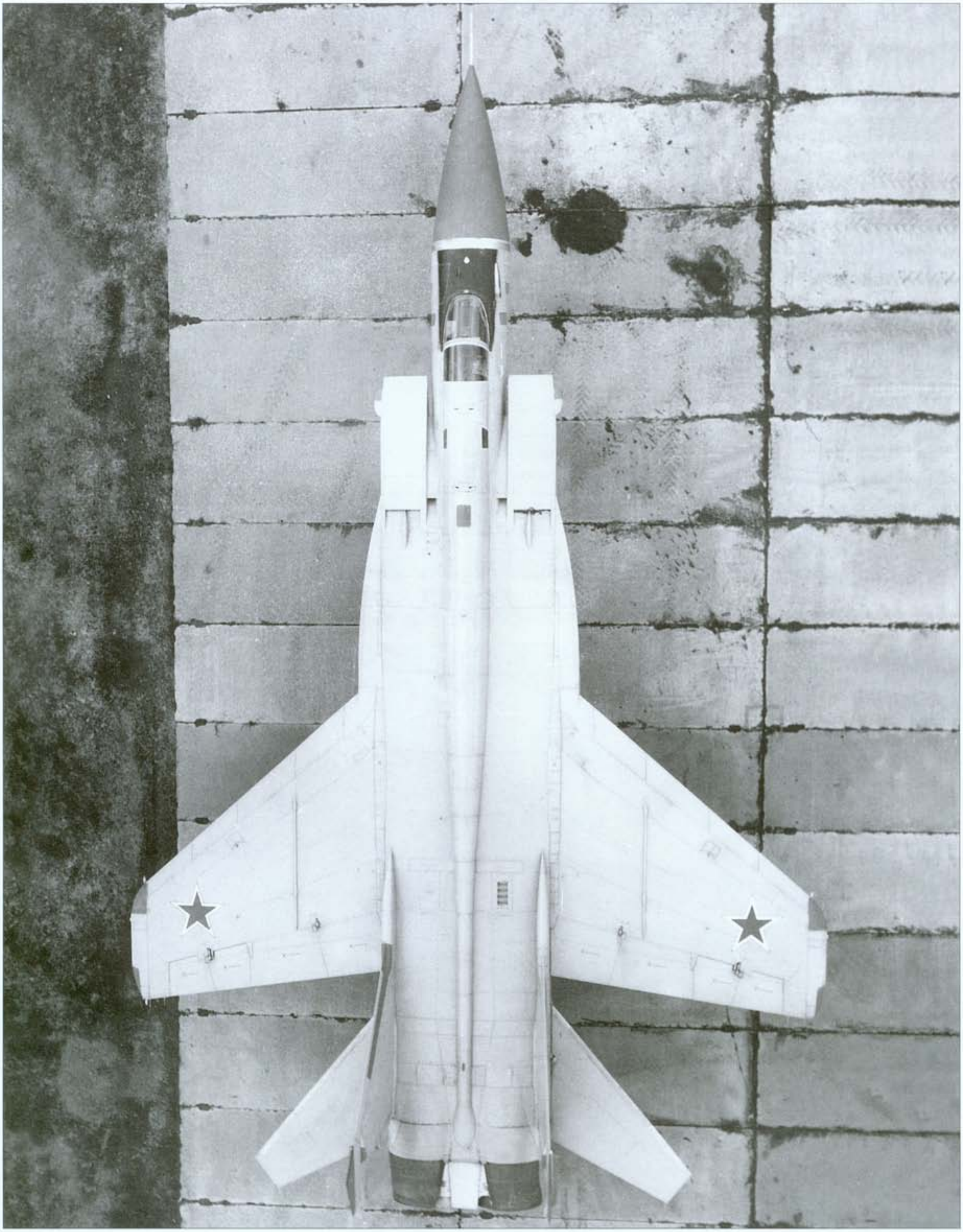

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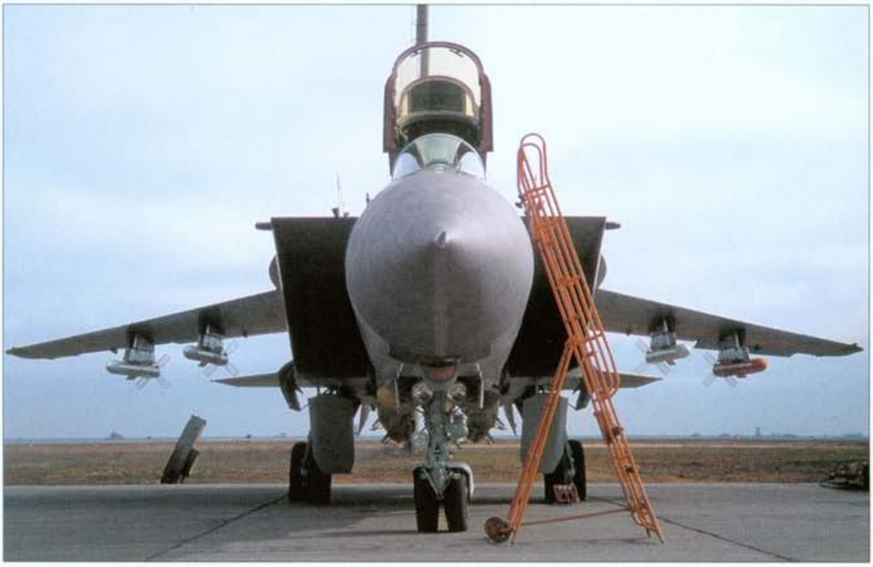


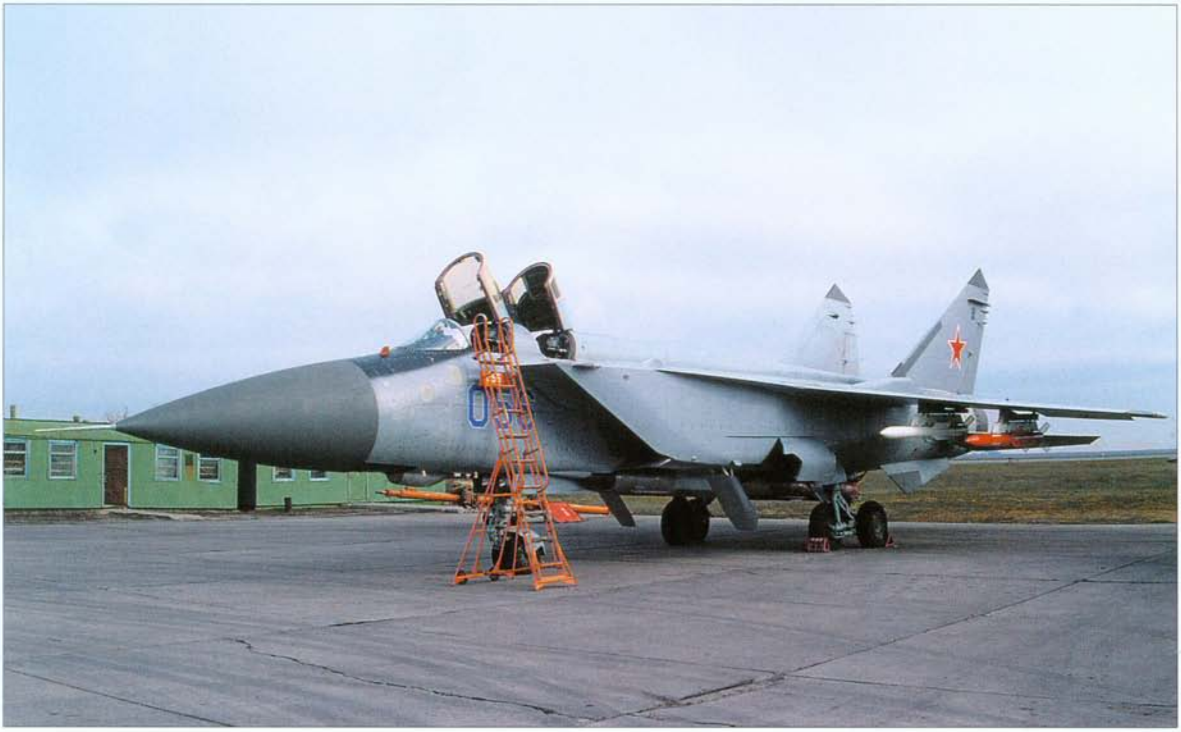
▶
A head-on view of '056 Blue', the fifth true prototype MiG-31M, on the ramp at Akhtoobinsk in 1992; this was the last of the prototypes to be completed in the same configuration as '052 Blue'. Note the ogival shape of the LERXes and the four dummy R-77 (RVV-AE) medium-range missiles with characteristic lattice-like rudders carried on the wing pylons.

Yefim Gordon

27th December 1986 – again with Orlov at the controls. This aircraft conformed to the MiG-31M specs in both structure and equipment; unfortunately it was eventually lost in a crash.

As the prototypes were released by the factory, one by one they were flown to Akhtoobinsk to participate in the joint state acceptance trials. The third, fourth, fifth and sixth prototypes (coded '053 Blue' through '056 Blue') were structurally identical to the second aircraft. The seventh and final prototype, '057 Blue' (c/n N72100106137), incorporated changes made at the customer's request and as a result of the initial trials; in

A three-quarters front view of the same aircraft.
▼



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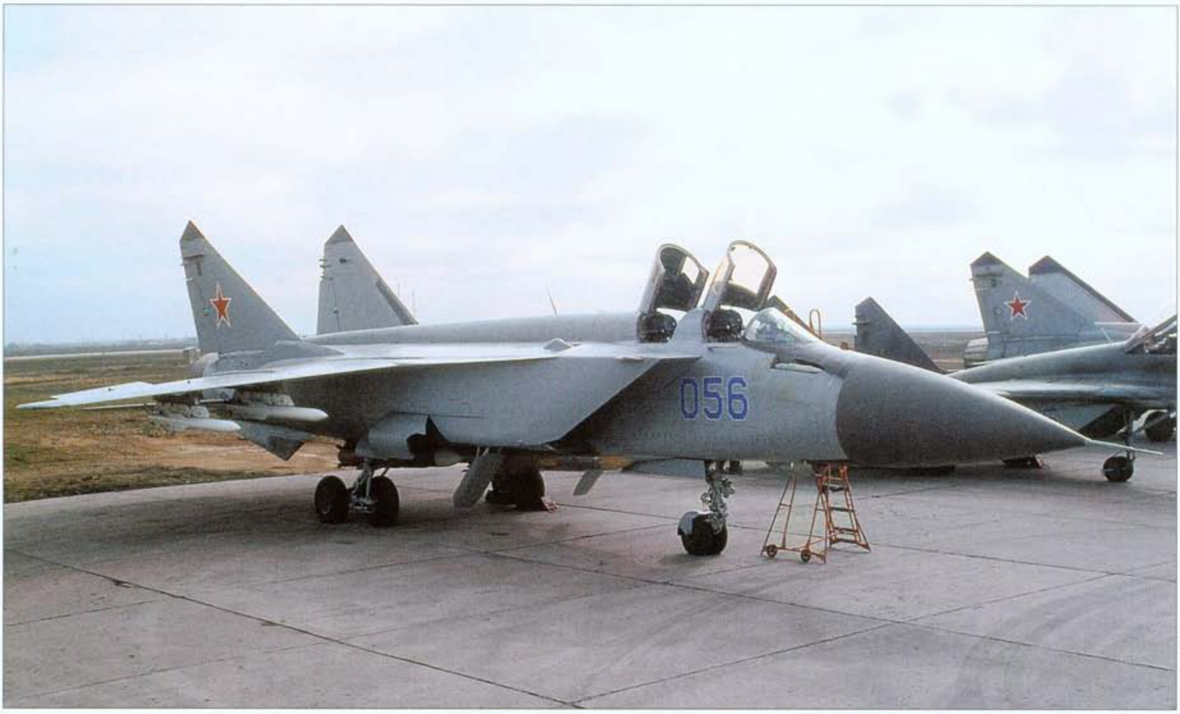
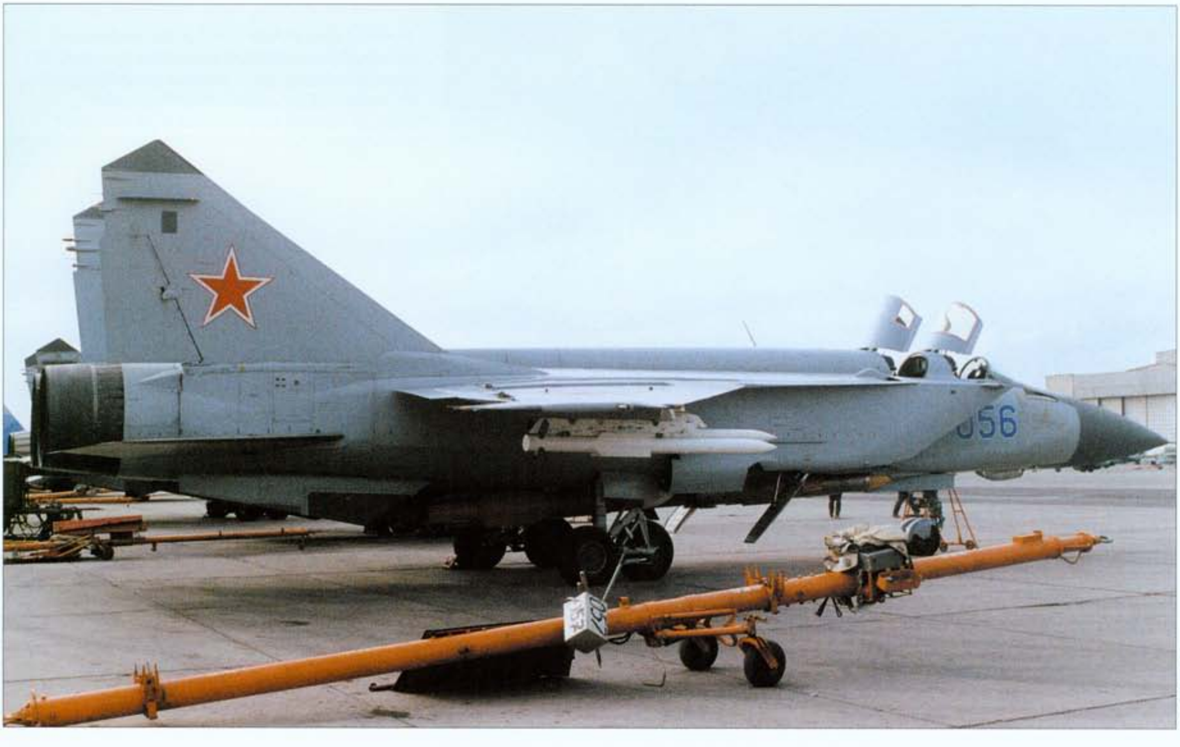

Yefim Gordon

Two more views of MiG-31M '056 Blue' sharing the ramp with two of its stablemates – a MiG-29 and a 'first-generation' MiG-31. Once again, the rear triplet of buried R-37 missiles is more exposed than the forward row.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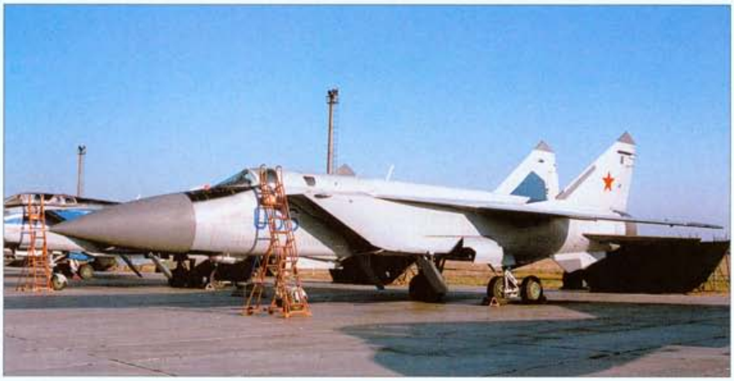
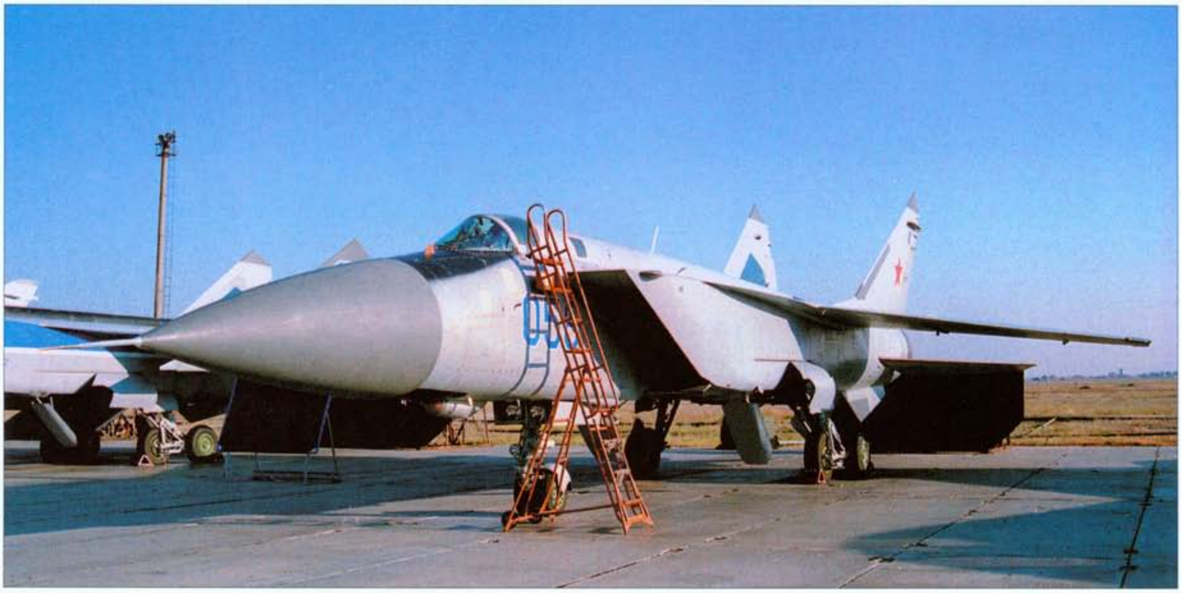
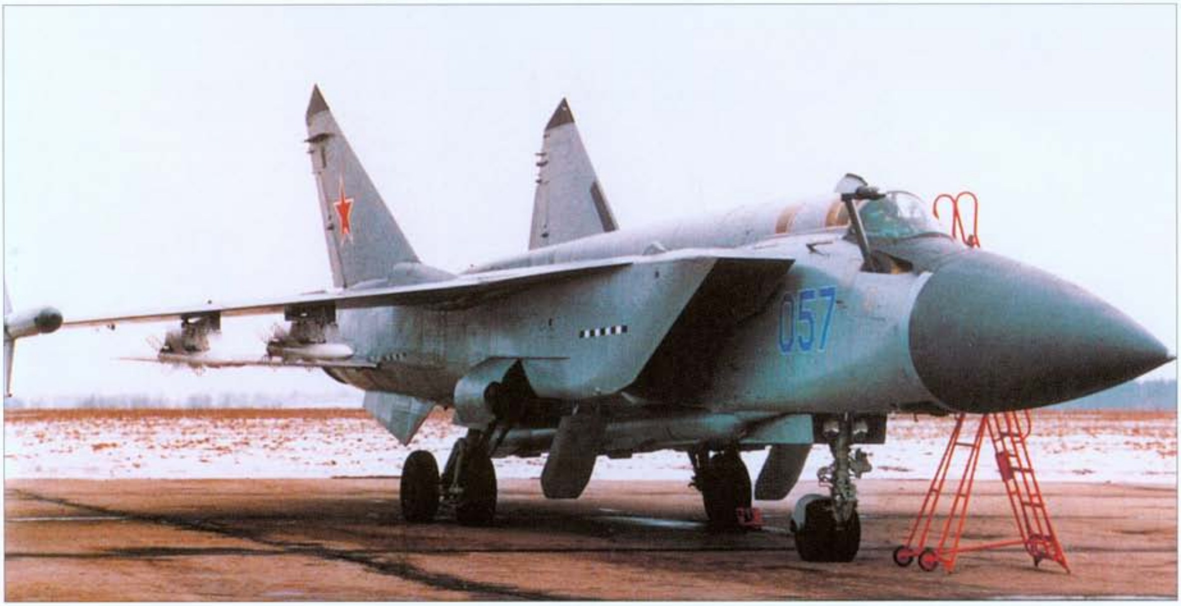
◄ A still from a documentary movie showing Mikoyan OKB employees beside MiG-31M '056 Blue' with both cockpits open.


Sergey Sergeyev

◄ The same aircraft parked beside a MiG-31 *sans suffixe* in OKB demonstrator colours ('374 White' or '903 White') at Vladimirovka AB, Akhtoobinsk, during the 'open house' on occasion of GK NII VVS's 75th anniversary in 2005.

Another view of '056 Blue' at the anniversary celebrations in Akhtoobinsk. Note the steel jet blast deflectors at the edge of the parking ramp. ▼

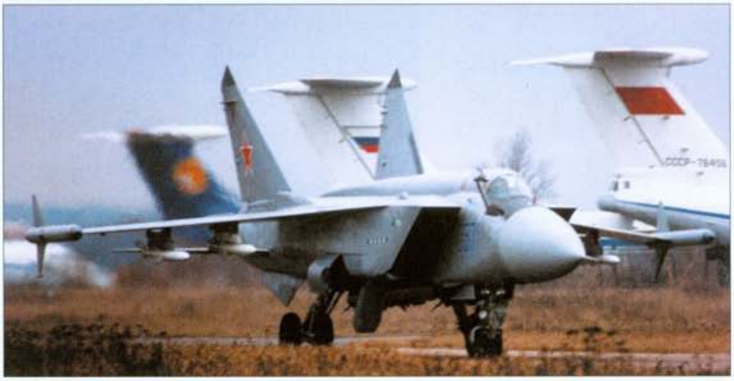

Sergey Sergeyev



Sergey Skrynnikov

▲
The final MiG-31M prototype, '057 Blue', sits at Machoolishchi AB near Minsk on 13th February 1992 during a special military aviation hardware display staged for the benefit of the CIS heads of state and military top brass.

►
The same aircraft taxies in at Zhukovskiy past an Ilyushin/Beriyev 'aircraft 976' telemetry pick-up aircraft (CCCP-76456), an Ilyushin IL-76 transport, an IL-62M of long-defunct Moscow Airways (RA-86515) and an IL-18 as it arrives from Akhtoobinsk for the MAKS-97 airshow. Note that the IFR probe is deployed.
▼



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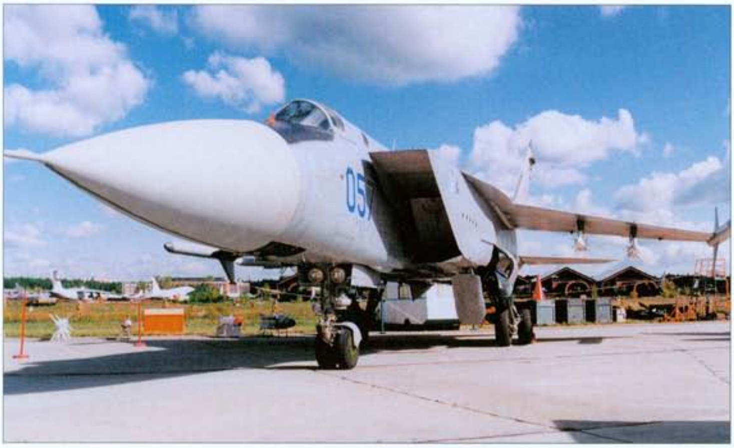
Yefim Gordon archive

particular, the wings were tipped with ECM pods sporting small delta fins projecting up and down at the rear to improve directional stability. Apart from the loss of the second prototype, the first flying example ('051 Blue') was dismantled upon completion of the trials, as was the static test article.

Having got off to a good start, the tests of the MiG-31M effectively ground to a halt in the late 1980s/early 1990s when actual weapons trials began. The designers' wish to create an ultra-long-range missile surpassing the American AIM-54 Phoenix in all respects (the R-37) proved the proverb about good intentions. With so many guidance modes incorporated into the seeker head, it proved impossible to ensure adequate reliability while keeping size



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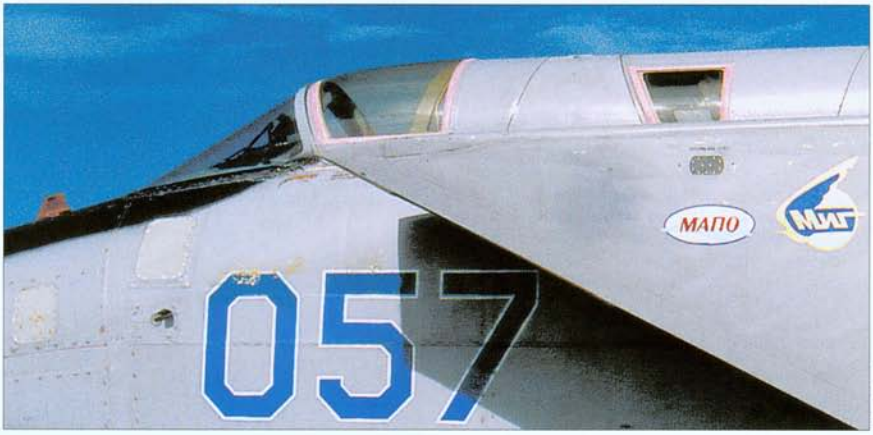
▲ The final prototype, '057 Blue', incorporated substantial changes based on the results obtained with the previous MiG-31Ms, including wingtip-mounted ECM pods with stabilising fins.



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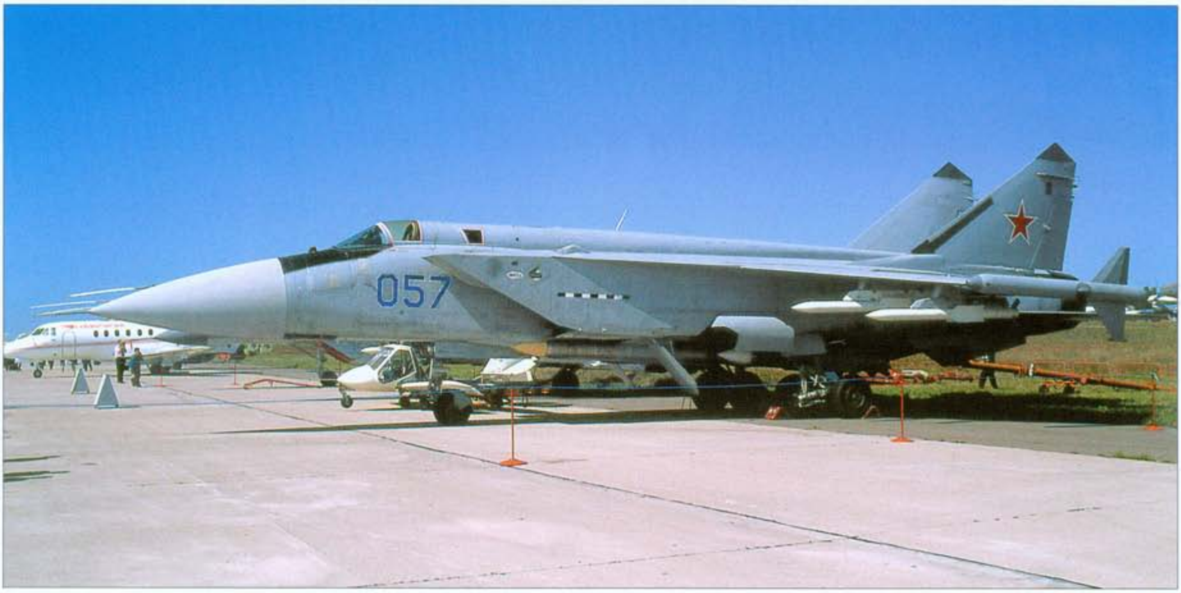
► Close-up of the MiG-31M's cockpit canopies.

MiG-31M '057 Blue' in the static park at the MAKS-99 airshow. ▼



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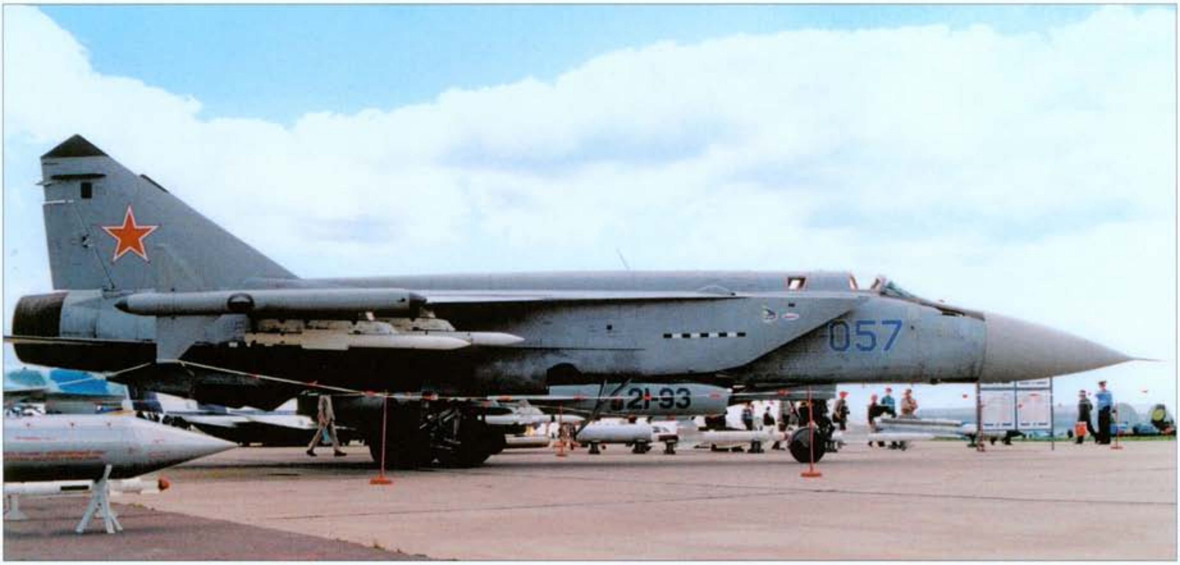

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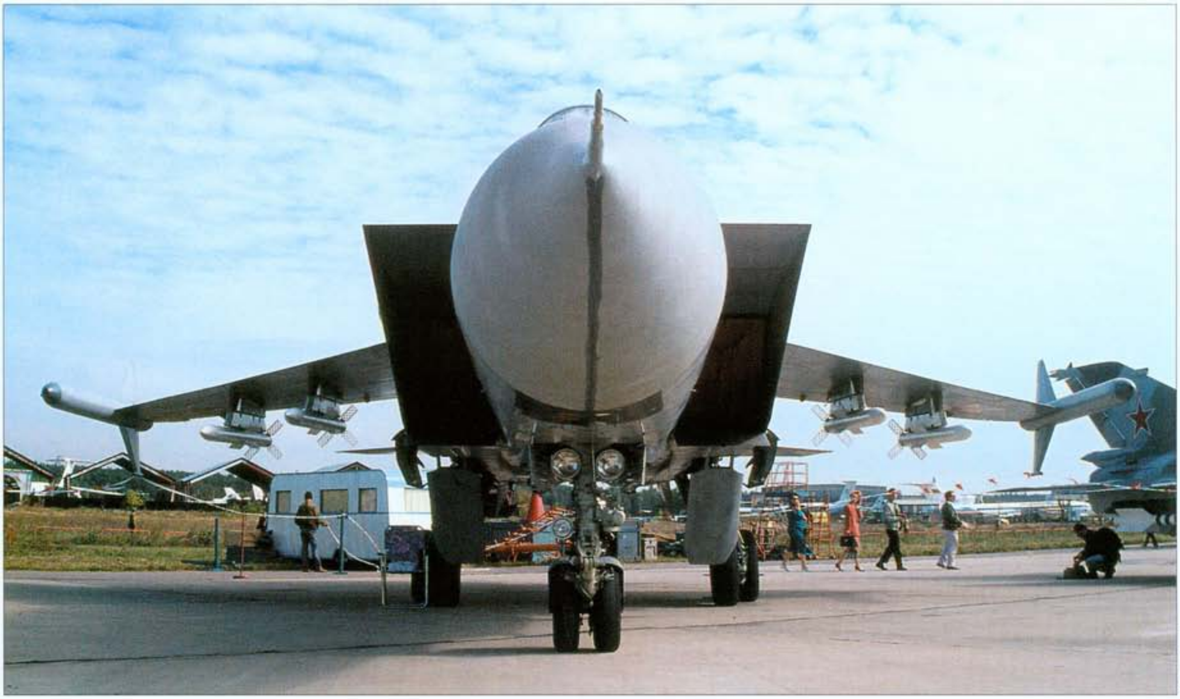
and weight within the rigid limits imposed by the customer. As a result, after launch the R-37 invariably proved to have a mind of its own, going just about anywhere except in the direction of the target.

Due to the economic downturn caused by the disintegration of the Soviet Union, the meagre funds allocated for the MiG-31M programme were insufficient, of course. The money was 'spread out thinly' over a multitude of programmes; the aircraft design bureaux acting as general contractors allocated only a small proportion of what little was available to the subcontractors responsible for the engines, avionics, systems and armament. As a result, it was the lack of a high-

▲
Another view of the final MiG-31M at the MAKS-97.

Head-on view of '057 Blue'. Unlike the earlier prototypes, the IRST is completely buried when not in use.
▼



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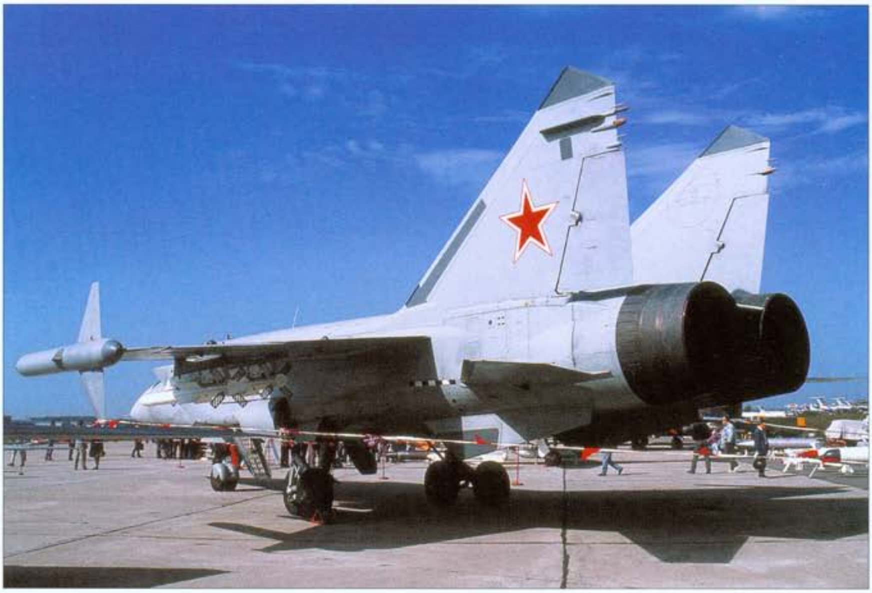
This three-quarters rear view of MiG-31M '057 Blue' shows the nozzles of the D30F-6M engines and the dielectric rear portions of the wingtip ECM pods. Lateral antennas are mounted about half-way along their length.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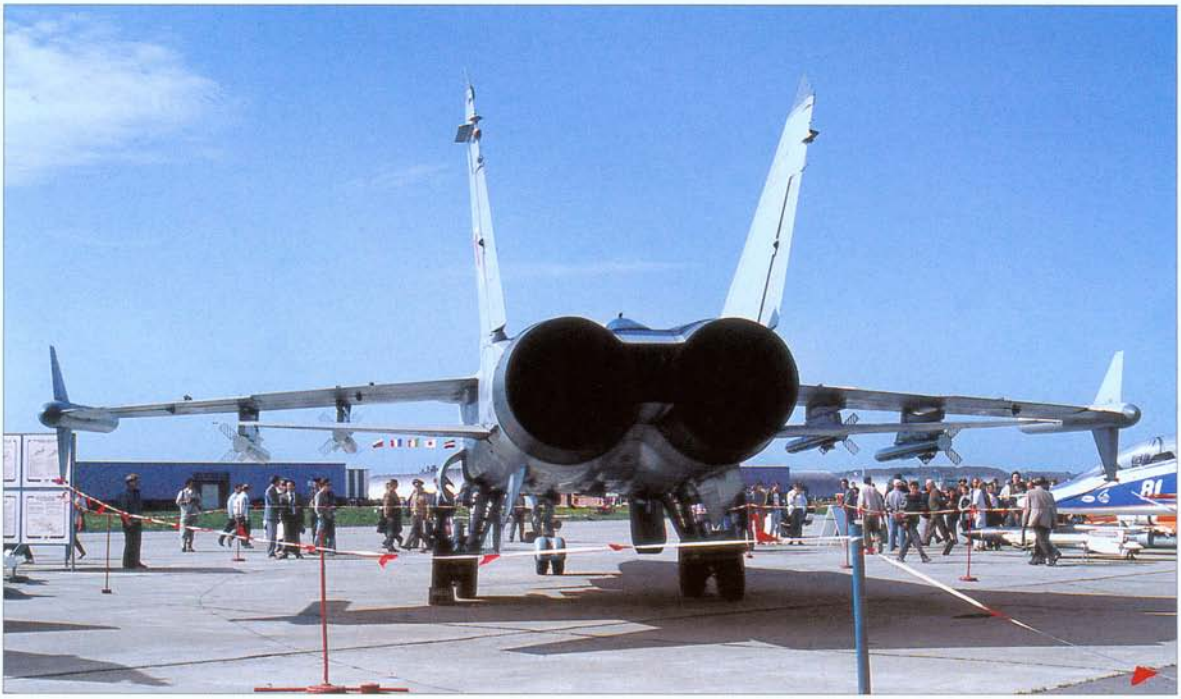
quality 'filling' that prevented the 'pie' from being 'baked' – in other words, the MiG-31M and the other Generation 4+ combat aircraft (the Su-27M, the MiG-29M and later the *izdeliye* 1.44 fifth-generation fighter) were unable to complete, or even begin, their state acceptance trials.

On 13th February 1992 MiG-31M '057 Blue' was demonstrated to the political and military leaders of Russia and some other member nations of the Commonwealth of Independent States (CIS) at Machoolishchi AB near Minsk, Belorussia, along with the other latest Soviet military aircraft. The data

A rear view of the MiG-31M. Unlike the 'first-generation' versions, there is no exposed brake parachute housing.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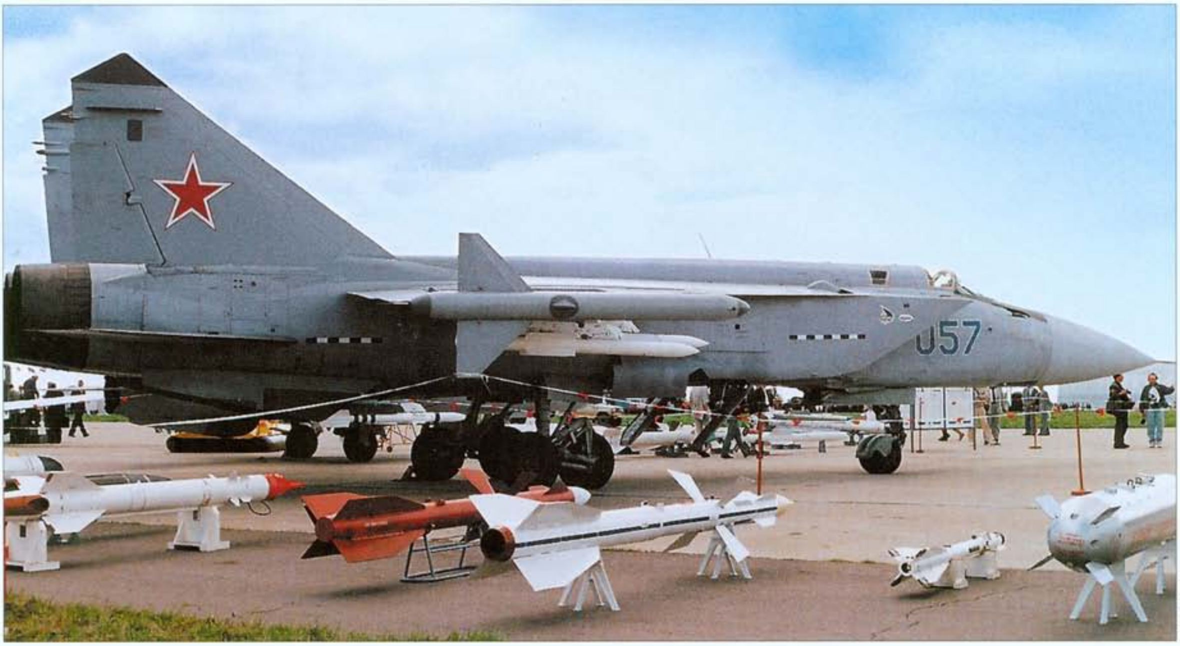

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placards in front of the aircraft were draped over with black cloth to conceal the 'top secret' figures from the journalists, who arrived in force; obviously *glasnost'* (the new Soviet policy of openness) still had a long way to go in 1992! The first public appearance of the same aircraft took place at the MAKS-95 airshow in Zhukovskiy on 22nd-27th August 1995.

In April 1994 Russian President Boris N. Yel'tsin sent a telegram to the creators of the MiG-31M and its weapons system, congratulating them on the successful live air-to-air weapons trials at ultra-long range. For the first time in the world a missile fired by a MiG-31M had destroyed a target drone at 228 km (141 miles) range.

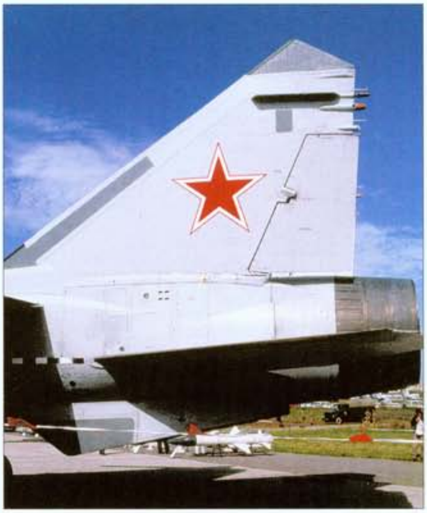
Still, despite the success of the initial tests, the highly effective weapons system comprising the MiG-31M aircraft, the Zaslon-M WCS and the R-37 missile proved too costly and did not enter production because the Russian Ministry of Defence could not afford to order it. However, some features of the MiG-31M were later incorporated into yet another upgrade package developed for the MiG-31.

The MiG-31M (*izdeliye* 05) served as the basis for two more advanced versions designated *izdeliye* 05B and *izdeliye* 05BM. No information on these aircraft has been released for publication so far.

MiG-31BM Interceptor (*Izdeliye* 01BM)

When state funding of military programmes was reduced to a trickle after the break-up of the Soviet Union and purchases of the MiG-31M became impossible, in 1997 the Mikoyan OKB launched a programme to upgrade the MiG-31Bs operated by the Russian Air Force to a new multi-role version designated MiG-31BM. The aircraft was to possess both a much-enhanced counter-air capability and a strike capability.

▲
This view illustrated the shape and size of the wingtip fins enhancing directional stability. The ECM pods protrude a great deal ahead of the wing leading edge.



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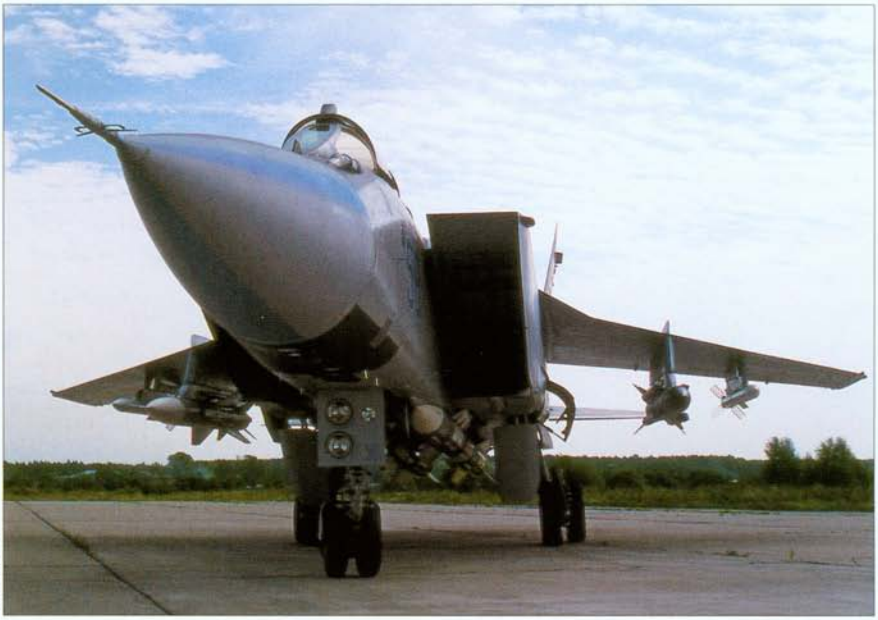
Close-up of the MiG-31M's port fin. The increased-chord rudders extend beyond the fins' trailing edges.



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'58 Blue' (c/n N38401214306), the prototype of the multi-role MiG-31BM, was converted from a regular in-service MiG-31B. The addition of several new modules into the weapons control system gives the MiG-31BM air-to-ground capability for no reduction of its counter-air capabilities.

►

The photographs on pages 91-93 show the MiG-31BM prototype during tests. The blue stripes on the radome are explained by the fact that the radome was borrowed from MiG-31 '374 White', the demonstrator wearing that special colour scheme.

The main changes were as follows. The radar was to be upgraded in order to extend the acquisition range against controlled and ballistic aerial targets and enable detection of small surface targets on land and at sea. The weapons range was to be updated significantly by integrating new AAMs (including the R-77, R-33S and R-37), air-to-surface missiles (Kh-25, Kh-31, Kh-59, Kh-29) and guided bombs (KAB-500 and KAB-1500), with a total ordnance load of up to 8 tons (17,640 lb). The new AAMs were to expand the targets' speed and altitude envelope, enabling the destruction of such targets as theatre and intermediate-

This view illustrates the Kh-31P anti-radiation missiles on the MiG-31BM's inboard wing pylons. R-77 (RVV-AE) air-to-air missiles are carried on the outer pylons.
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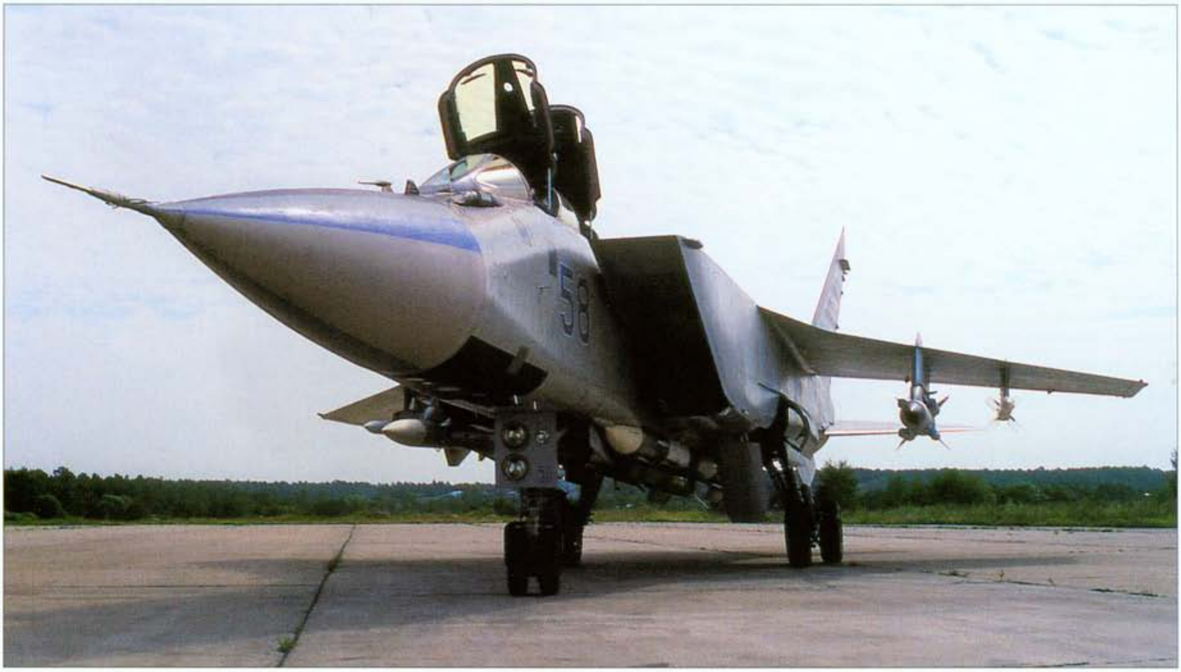

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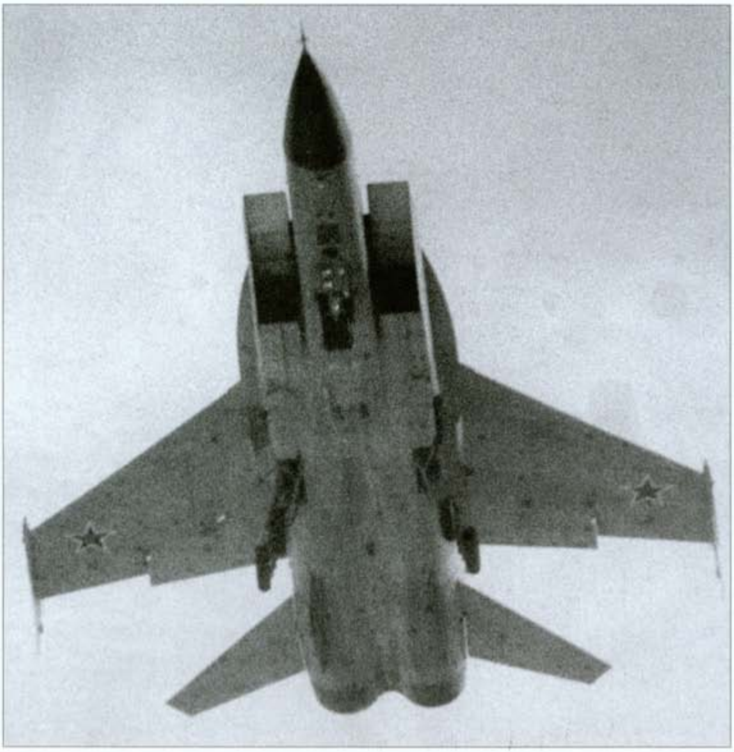


Victor Drushlyakov

▲ **'072 Blue', the second prototype of the highly specialised MiG-31D – a launch platform for an anti-satellite missile. This view shows well the curved LERXes (which are identical to those of the MiG-31M) and the absence of the ventral recesses for the R-33 missiles.**

range ballistic missiles, hypersonic and trans-atmospheric vehicles.

The cockpits were to be equipped with large colour multi-function displays (MFDs) and multi-function control keypads. The avionics architecture was to include state-of-the-art data processors and multiplex databuses. Finally, new ECM gear was to be fitted.

The aircraft was to feature an upgraded weapons control system incorporating the know-how accumulated in the development of the RP-31M (Zaslon-M). In particular, the radar set was to feature a new receiver and a new signal processor. This increased the acquisition range to 320 km (198 miles) and maximum 'kill' range to 280 km (174 miles). The upgraded radar was capable of tracking up to 15 targets and guiding missiles to six priority threats at once. The avionics suite featured a MIL-STD-1553B databus.

The ***Roos**skaya **Avio**nika* (Russian Avionics) Joint-Stock Co. developed a completely new layout for the MiG-31BM's cockpits. The chief shortcoming of the existing layout was the pilot's lack of tactical situation awareness: the pilot had no idea what the WSO was doing until the latter told him. On the MiG-31BM a 6x8" multi-function liquid-crystal display was installed on the right-hand side of the pilot's instrument panel. There were more radical changes in the WSO's cockpit which had three such LCD screens. These could display all manner of information (tactical situation overview, navigation data, radar imagery, a 'bomb's eye view' generated by TV-guided bombs/missiles etc.). The forward cockpit also featured a new head-up display developed jointly by NIIP and NPO Fazotron.

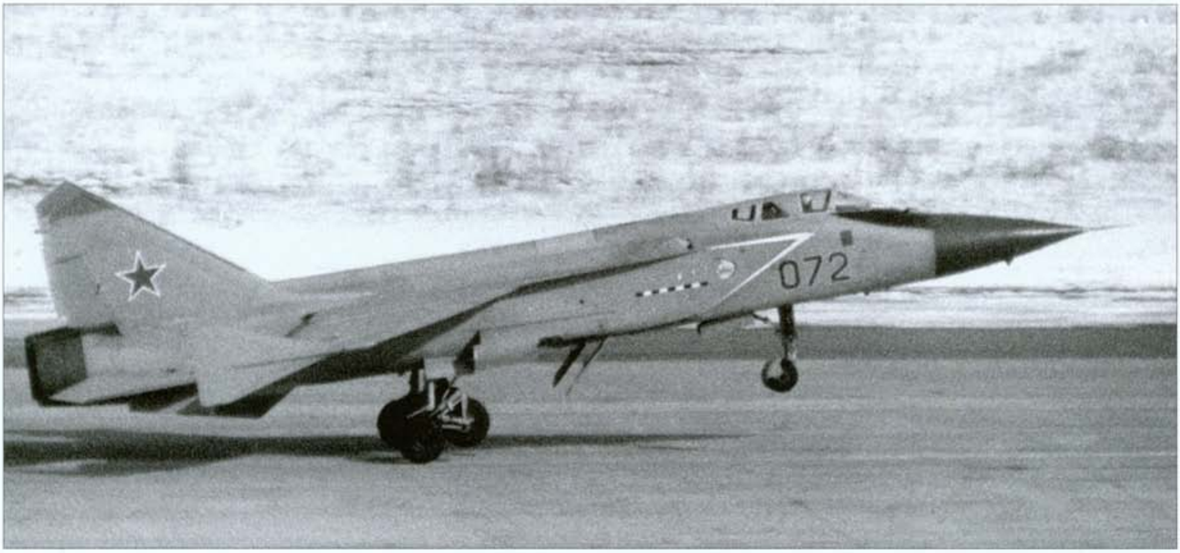
The combat efficiency of the upgraded MiG-31BM in counter-air mode was 2.6 times higher as compared to the baseline interceptor. The aircraft was expected to be capable of intercepting targets travelling at speeds up to Mach 6; other performance parameters were likewise improved.

Two prototypes were to participate in the trials programme, whereupon a fleetwide conversion programme was to begin. The first prototype was converted from a new MiG-31B coded '58 Blue' (c/n N38401214306) in 1998; it was officially unveiled at Zhukovskiy on 12th January 1999 together with the Mikoyan '1.44' fifth-generation fighter technology demonstrator. Same year '58 Blue' was in the static park at the MAKS-99 airshow on 17th-22nd August, featuring a grey/white/blue striped radome borrowed from a company-owned MiG-31 demonstrator in a special colour scheme (most likely '374 White').

Operational MiG-31Bs and 'BSs were to be upgraded to MiG-31BM standard. However, Russia's financial troubles and the consequent lack of funding for the programme meant that the costly full-scale tests of the MiG-31BM were never performed. The Russian MoD was more worried about keeping existing aircraft airworthy; allocating funds for a costly upgrade was out of the question in the late 1990s when Russia was still suffering from the 'Black Monday' (17th August 1998) bank crisis. The idea of upgrading the *Foxhound* was dusted off in the early years of the new century, but so far no information has been forthcoming on the programme's progress.

MiG-31D Experimental Interceptor (*Izdeliye* 07)

In 1987-89, when anti-missile defence (AMD) programmes were strongly on the agenda, the Mikoyan OKB built two prototypes of a highly specialised version of the MiG-31. The aircraft was designated MiG-31D and known in-house as *izdeliye* 07; accordingly the two aircraft were coded '071 Blue' and '072 Blue'.



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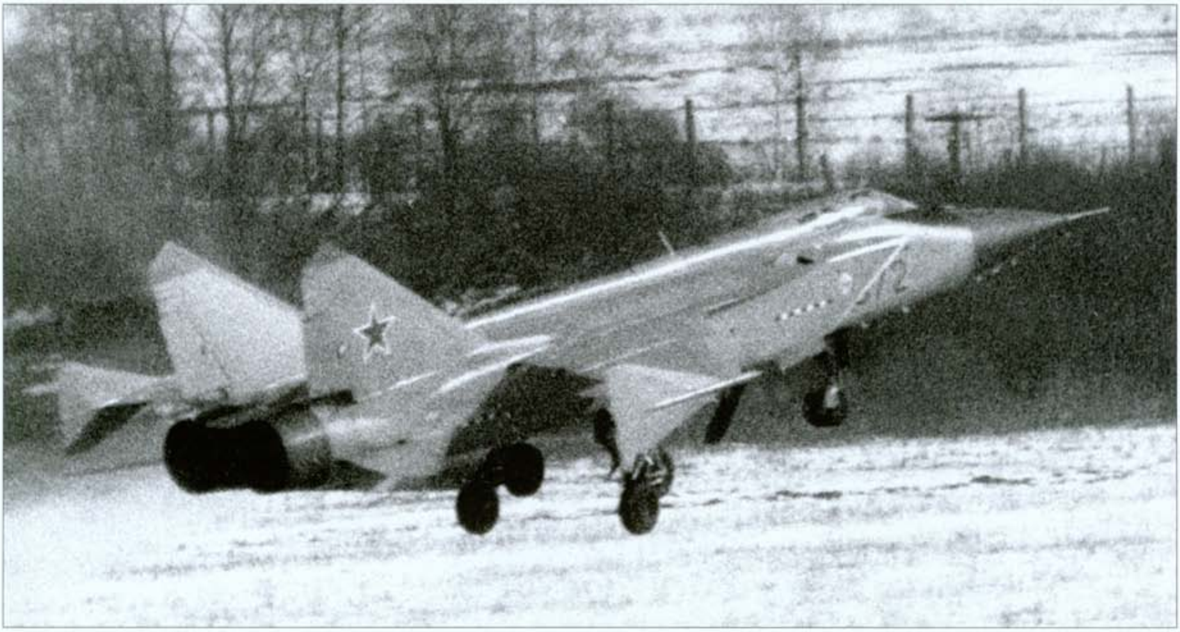

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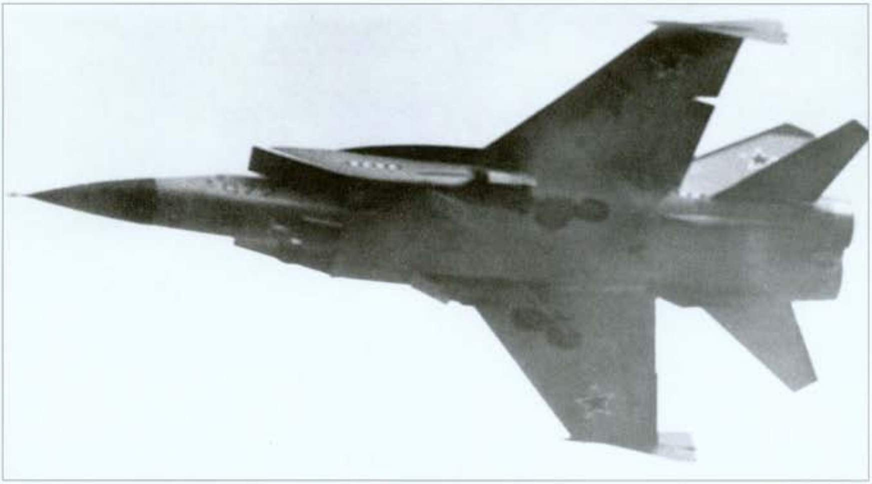
Caught by the camera as it becomes airborne from runway 12 at Zhukovskiy, MiG-31D '072 Blue' displays clearly the huge delta-shaped wing endplates and extended-chord rudders enhancing directional stability and control in the rarefied air of the high altitudes where the launch was to take place.

The MiG-31D was a suborbital launch vehicle for an anti-satellite ballistic missile carried on the fuselage centreline; thus it was the Soviet counterpart of the US system based on the McDonnell Douglas F-15 Eagle fighter and the ASAT missile known as a suborbital ballistic kinetic kill vehicle (SBKKV). The MiG-31D featured mission avionics enabling the complex flight path which the aircraft was to follow in order to set the missile's inertial navigation system for launch. The aircraft's avionics also enabled automatic course correction as ordered by the ground control centre. Accelerating in level flight, the aircraft was to pull up into a zoom climb, maintaining the correct altitude, speed, trajectory angle and geographic co-ordinates while following a pre-planned time schedule.

The MiG-31D differed from the basic *izdeliye* 01 primarily in lacking the latter's armament and WCS. The recesses in the fuselage underside for the R-33 missiles were



Another lower view of the MiG-31D. The LERXes served not so much to improve low-speed handling but rather to generate additional lift at high altitude. Note the black and white photo calibration markings.

Victor Drushlyakov

eliminated; the LERXes were enlarged, featuring the same curved shape as on the MiG-31M. To ensure directional stability with the SBKKV in place, large delta-shaped endplates were fitted to the wings; these promptly earned the nickname ***las**ty* (webbed feet, or flippers). Development of the MiG-31D's specialised weapons system at the Mikoyan OKB was supervised by V. M. Polyakov.

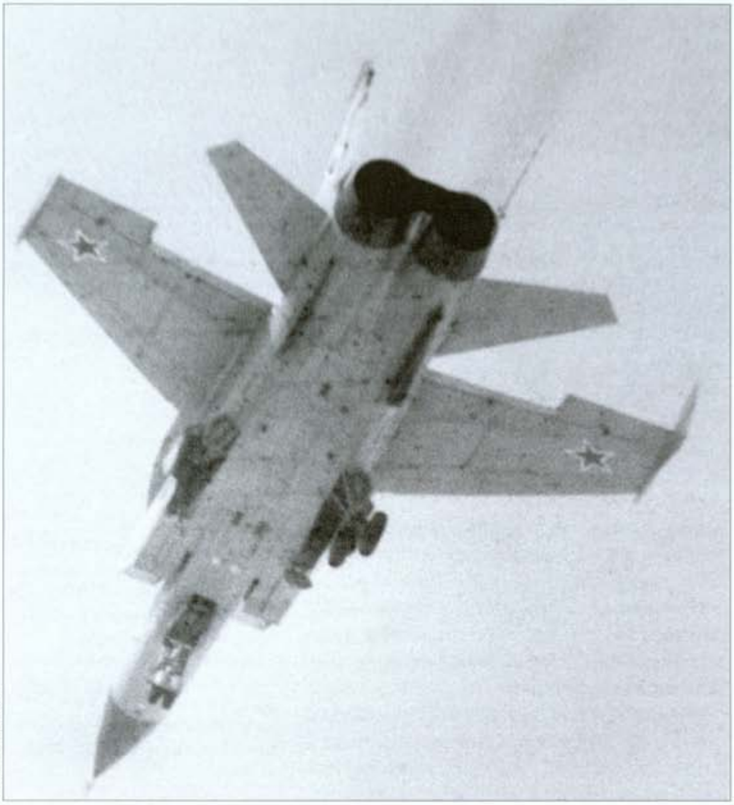
Merited Test Pilot Aviard G. Fastovets flew the MiG-31D on its maiden flight. This was to be the last aircraft which he tested; in 1990 failing health forced Fastovets to give up flying. In fact, as early as 1987 the medical examiners had banned him from flying any aircraft which did not have dual controls (that is, so that another pilot would be there to take over, should Fastovets feel unwell). Now the MiG-31D was not supposed to have dual controls; however, Mikoyan OKB chief test pilot Valeriy Ye. Menitskiy was firm in his belief that only a top-notch pilot such as Fastovets was to take the machine (which was expected to be quite a handful) up on its first flight. Hence the prototype had to be fitted with a second set of controls in order to comply with the medics' requirements.

The two prototypes underwent tests for several years; besides Fastovets, the MiG-31D was flown by Anatoliy N. Kvochur, and the greater part of the programme was performed on '072 Blue'. In the early 1990s, however, the programme was put on ice due to lack of funding.

MiG-31S Suborbital Launch System (Project)

The MiG-31D served as the basis for a suborbital launch system designated MiG-31S. The aircraft was to carry a small space launch vehicle for placing small satellites into low Earth orbit. In this case the requirements concerning the launch co-ordinates and the setting accuracy of the rocket's INS were much less stringent.

The MiG-31D leaves a sooty trail as it comes in to land at Zhukovskiy. Judging by the shape of the nozzles and the area between them, th aircraft may be powered by the uprated D30F-6M engines. The centreline pylon for the anti-satellite missile is not fitted.



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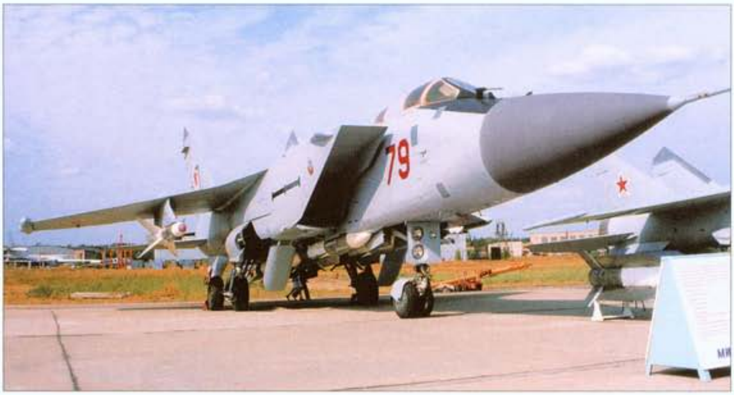

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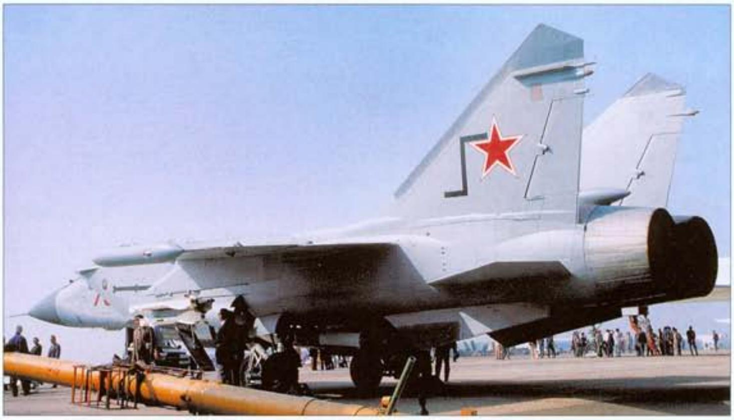

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Promising ways of further upgrading the MiG-31 included further extending the interceptor's range, installing a radar with an active phased array and implementing the bistatic radar detection principle for detecting and attacking stealth aircraft with a low radar signature. The prototypes and production *Foxhounds* participated in a multitude of R&D programmes involving interception of targets flying at ultra-low level, exploration of radar returns from the ground, guidance using satellites and over-the-horizon (OTH) targeting radars etc. Some of the test and development versions are described below.

MiG-31LL Ejection Seat Testbed

A single MiG-31 coded '79 Red' (c/n N69700115548) was modified for testing ejection seats and training flight crews in ejection procedures. This aircraft was known as the MiG-31LL (*le**ta**yushchaya labora**tor**iya* – lit. 'flying laboratory'; this Russian term is used indiscriminately for all sorts of testbeds and research/survey aircraft). The aircraft belonged to GNIKI VVS, which was renamed the Russian Air Force's 929th State Flight Test Centre named after Valeriy P. Chkalov (929th GLITs – *Gosoo**dar**stvennyy **lyot**no-ispy**tah**tel'nyy tsentr*) in the early 1990s.

Outwardly the MiG-31LL differed from standard machines in lacking the glazing on the inter-canopy crash frame and having small camera pods at the wingtips to record the ejection sequence. On 11th-16th August 1992 the aircraft was displayed statically at the MosAeroShow-92 in Zhukovskiy with a standard canopy over the rear cockpit. Curiously, the MiG-31LL sports nose art in the shape of a definitely moth-eaten lion's head. This is obviously a pun on the aircraft's testbed role: the Russian for 'bald lion' is ***lys**yy lev*, which abbreviates as LL (standing for *le**ta**yushchaya labora**tor**iya*, of course). In September 1995 the aircraft had another show performance,

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Though it is not obvious in these views, MiG-31 '79 Red' displayed at MosAeroShow-92 is the MiG-31LL ejection seat testbed.

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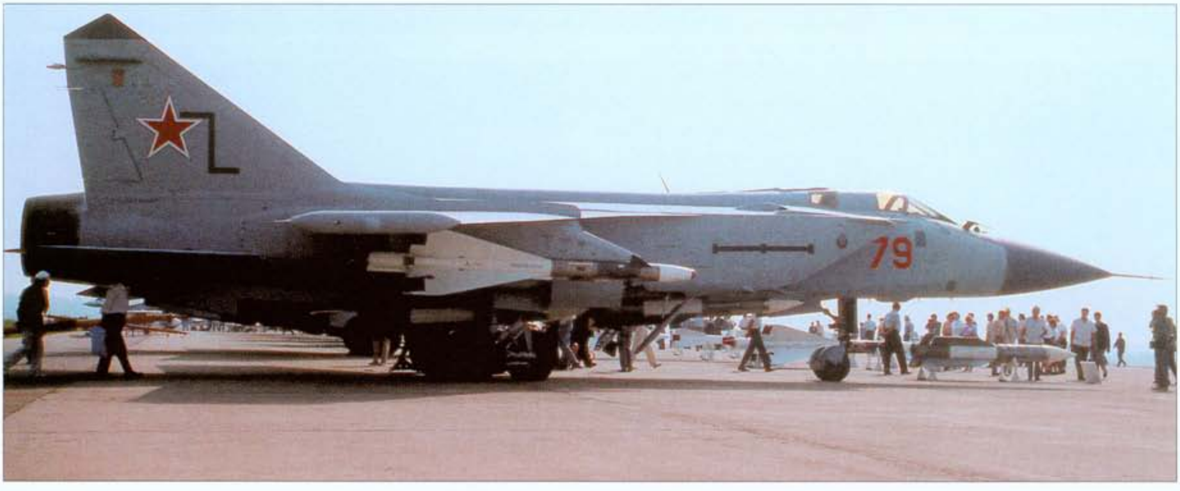

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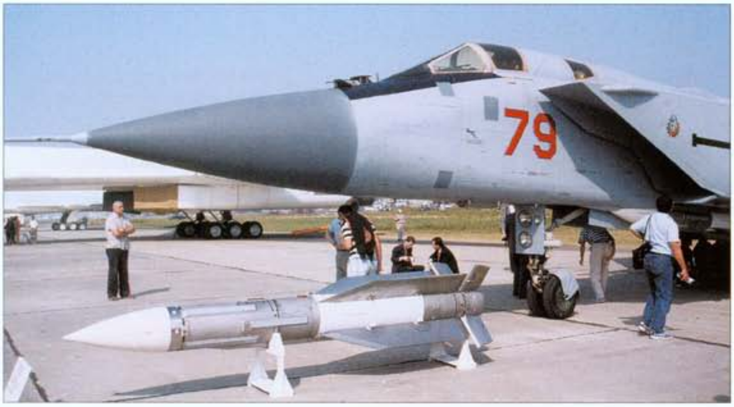


Yefim Gordon

▲ At MosAeroShow-92 in August 1992 the MiG-31LL carried a full complement of missiles – which had nothing to do with its testbed role. Note the absence of the usual glazing in the inter-canopy section and the bald lion artwork on the air intake, which conceals a pun hinting at the aircraft's mission.

demonstrating the ejection of a dummy from the rear cockpit during the take-off run at an 'open house' at Akhtoobinsk on occasion of the former GNIKI VVS's 75th anniversary.

MiG-31 Buran Approach Technique Testbed

A MiG-31 coded '97 Red' was used by LII for verifying the landing approach technique developed for the Soviet Union's ill-fated *Bu**ran*** (Blizzard) space shuttle. The technique involved a very steep approach followed by a flareout at extremely low level.

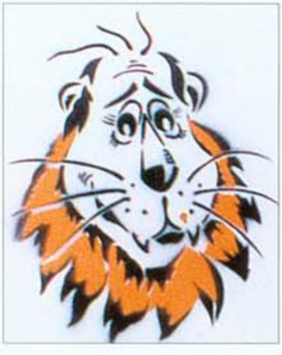
MiG-31E Export Interceptor

At various times such nations as Iran, Syria, Libya and China showed an interest in the MiG-31. Therefore, as early as 1987 a production MiG-31B (c/n N38401208786) was converted into the demonstrator of an export version designated MiG-31E (***eks**portnyy* – export, used attributively). The aircraft received distinctive blue/white trim over the standard overall grey colour scheme and the tactical code '903 White'.

The MiG-31E was armed with four R-33s (in an export version) and two or four 'dogfight missiles' on underwing pylons. The avionics fit (notably the IFF and ECM systems) was altered.

The MiG-31E's roles included acting as an airborne command post for other fighter types, such as the MiG-21, MiG-23 and MiG-29, which were in service with the air forces of the nations listed above. Therefore, even the purchase of a couple of MiG-31Es could bolster the customer nation's air defence appreciably.

'903 White' made its public debut at the ILA-92 airshow at Berlin-Schönefeld. Afterwards it participated in numerous other shows, including MAKS-99.



▲ The 'bald lion' artwork carried on the air intakes of the MiG-31LL ejection seat testbed.

MiG-31FE Multi-Role Tactical Fighter (Project)

In 1995 the Moscow Aircraft Production Association (MAPO MiG) unveiled yet another prospective version of the MiG-31 at the 41st Paris Air Show. Designated MiG-31FE (F = *fronto**voy*** – in this context, tactical), the aircraft was to have revised armament and new avionics enabling it to use most of the air-to-surface missile types on the Russian Air Force inventory.

The principal armament consisted of Kh-31P and Kh-25MP anti-radiation missiles for the suppression of enemy air defences (SEAD, or 'Wild Weasel') role, or active radar homing Kh-31A missiles for the anti-shipping role. Tactical strike weapons included two Kh-59M air-to-surface missiles or three Kh-59s *sans suffixe* featuring TV guidance; three of the lighter Kh-29L or Kh-29T ASMs (with laser or TV guidance respectively) could also be carried. Alternative ordnance loads included three 1,500-kg (3,310-lb) KAB-1500L or KAB-1500TK laser- or TV-guided 'smart bombs' or eight 500-kg (1,102-lb) KAB-500Kr guided bombs. The laser designator or TV guidance equipment was to be carried in podded form. The maximum warload was 9,000 kg (19,840 lb), which equals six FAB-1500 high-explosive 'dumb bombs'.

The Zaslon WCS was retained for use against aerial targets, working with R-37, R-77 and R-73 long-, medium- and short-range AAMs respectively. The MiG-31F could also carry a mixed ordnance load for attacking both ground and aerial targets (for instance, four Kh-31P/As and four R-77s); the air-to-surface weapons would be carried under the fuselage while the AAMs would be carried on wing pylons.

The MiG-31F's airframe and powerplant were to be virtually identical to those of the production interceptor; according to the customer's specifications the aircraft could be based on either the 'first-generation' *Foxhound* or on the 'second-generation' MiG-31M. The maximum take-off weight was 50 tons (110,230 lb). Range on internal fuel in subsonic cruise was estimated at 2,500 km (1,550 miles), increasing to 3,000 km (1,860 miles) with drop tanks, or 1,200 km (745 miles) in supersonic mode. The speed figures were expected to be similar to those of the standard aircraft, with a 3,000-km/h top speed at high altitude and a supersonic cruising speed of 2,500 km/h. Western avionics could be integrated at the customer's request.

▶
The same aircraft at the GNIKI VVS facility in Akhtoobinsk, its home base, in 1994. This time there are no more missiles.

Further views of the MiG-31LL at the Akhtoobinsk test centre. The cylindrical wingtip pods house video or cine cameras recording the ejection sequence. For ejection seat tests the rear canopy is replaced by a special open-top fairing. The kinked shape of the photo calibration markings on the fins makes it possible to measure the angle which the seat assumes after leaving the cockpit.
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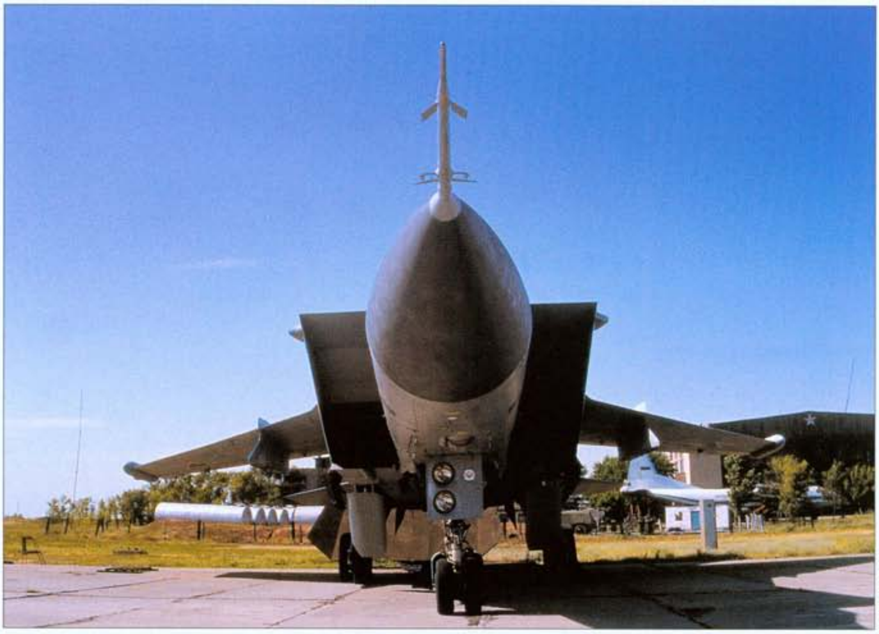

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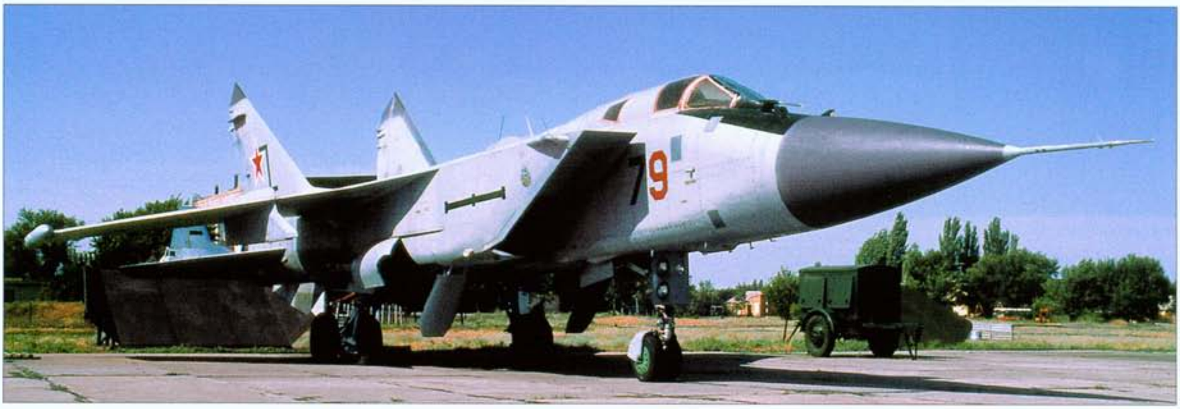

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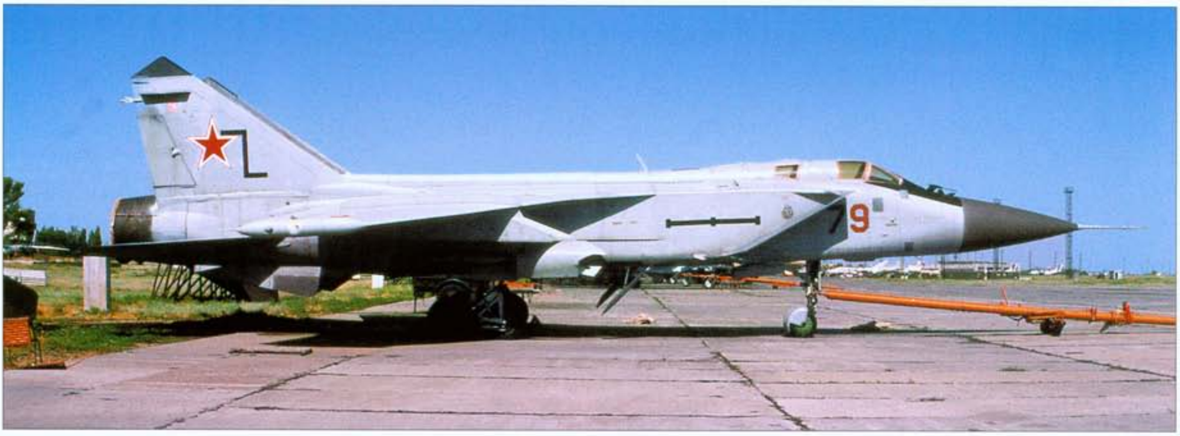

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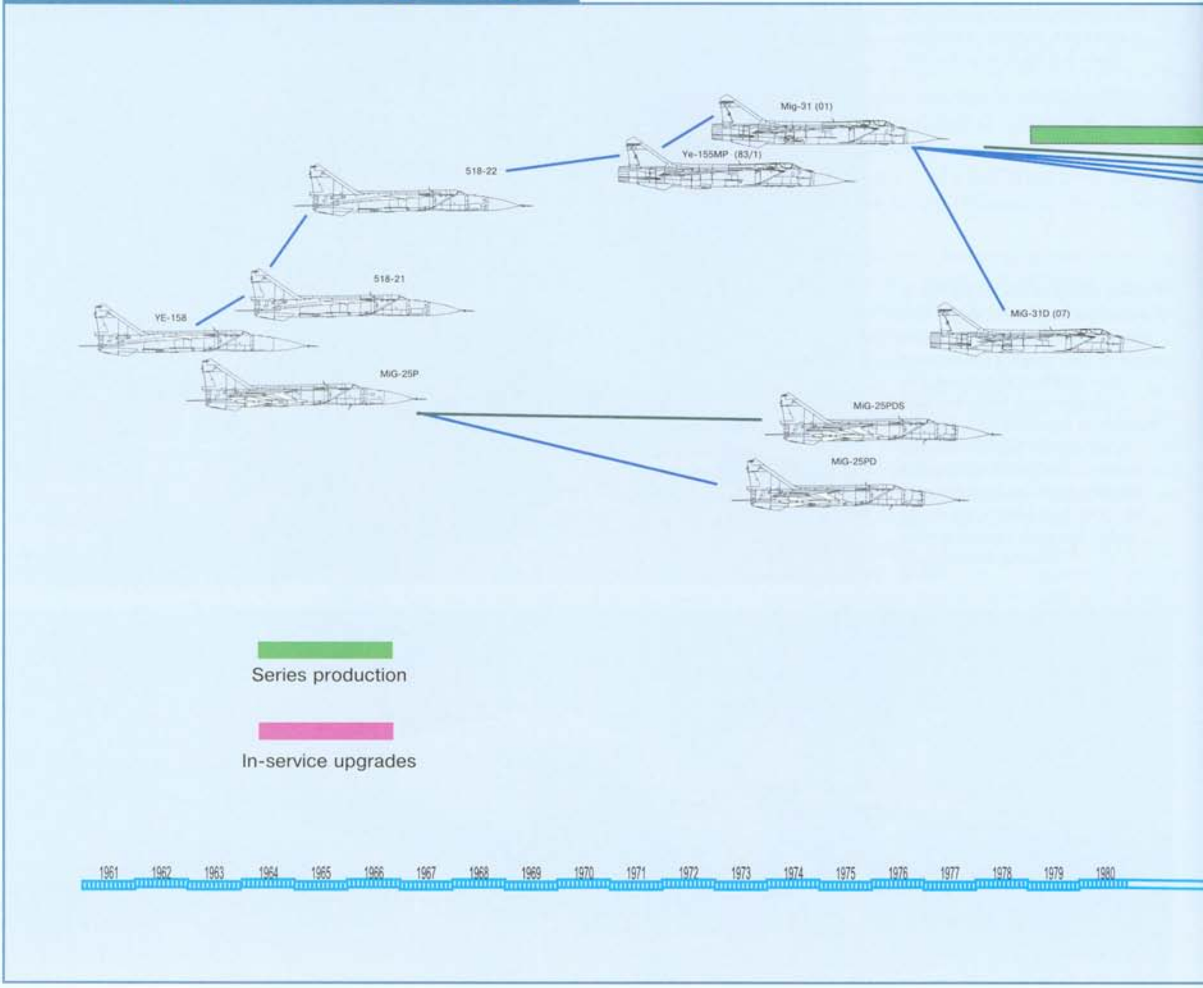
MiG-31 Interceptor - Version Development Diagram


Mig-31 (01)
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YE-158
MiG-25P
MiG-31D (07)
MiG-25PDS
MiG-25PD
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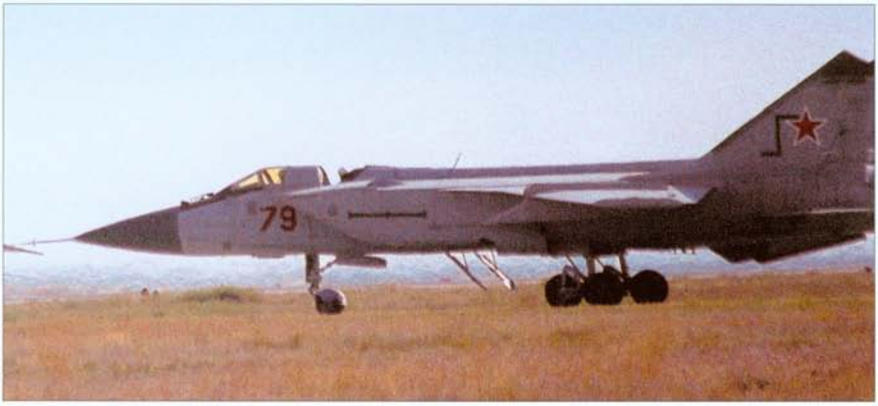
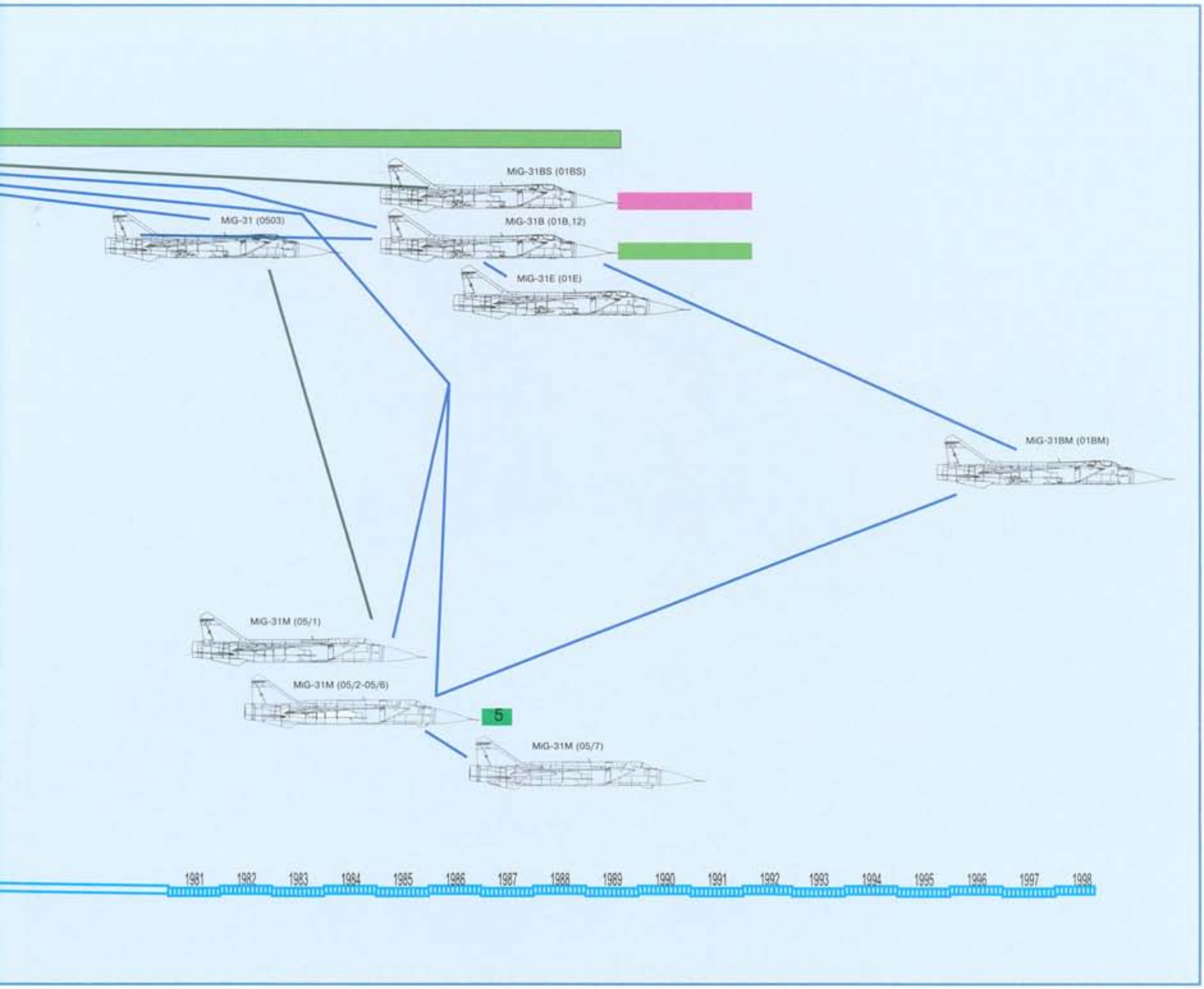


Sergey Sergeyev

◄ **MiG-31LL '79 Red' begins its take-off run at the 'open house' at Vladimirovka AB, Akhtoobinsk, on occasion of the 929th GLITs's 75th anniversary in 1995. Note the open rear cockpit occupied by a dummy in a 'bone dome' (for appearance's sake).**


MiG-31BS (01BS)
MiG-31 (0503)
MiG-31B (01B,12)
MiG-31E (01E)
MiG-31BM (01BM)
MiG-31M (05/1)
MiG-31M (05/2-05/6)
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MiG-31M (05/7)
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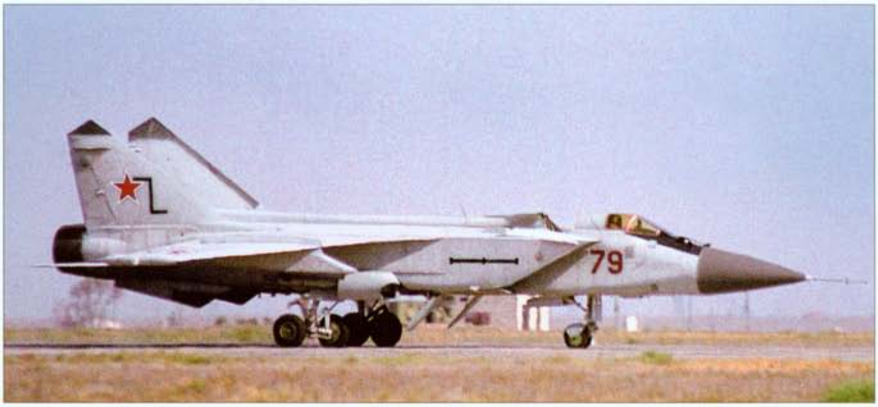
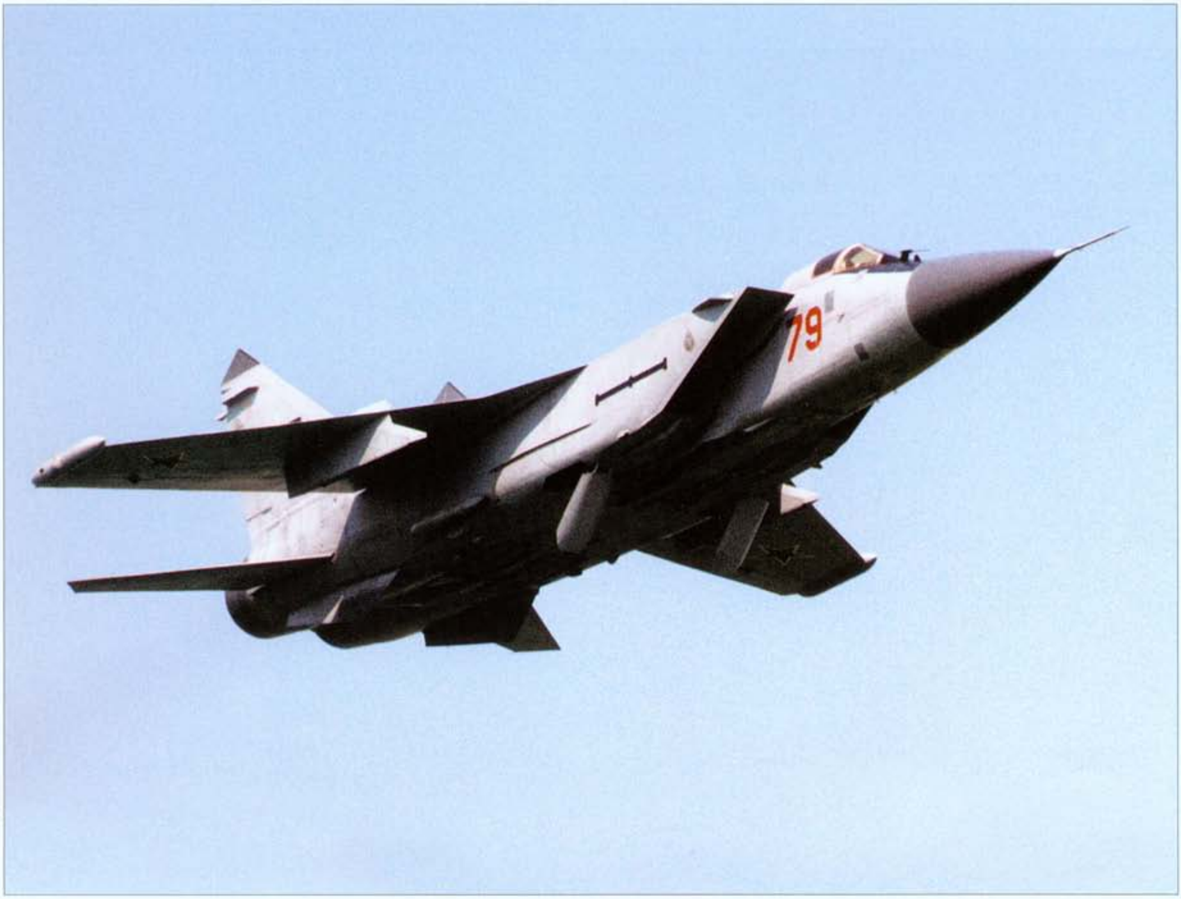


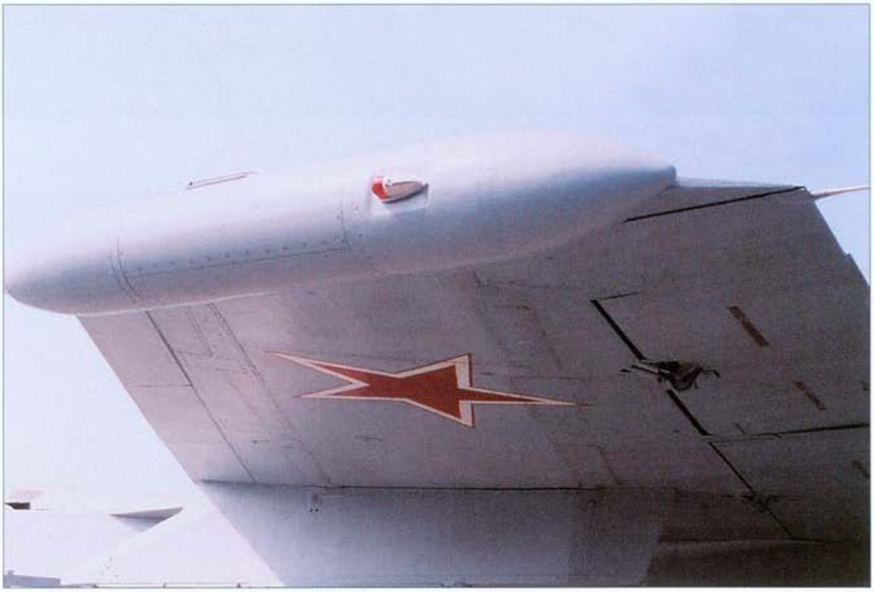
▶ **Another view of the MiG-31LL as it comes back after the demonstration flight. The empty rear cockpit and the powder stains immediately aft of it are easily visible. Most of the Soviet/Russian ejection seat testbeds were operated by the Flight Research Institute; the MiG-31LL was the only such aircraft operated by the former GNIKI VVS (now 929th GLITs) for checkout purposes.**

Sergey Sergeyev



Victor Drushlyakov

▲
The MiG-31LL makes a flypast during one of the many air events at Moscow-Tushino airfield, its airbrakes deployed to reduce speed.



Yefim Gordon

►
Close-up of the port wingtip camera pod of the MiG-31LL.

PART THREE

MiG-31 IN ACTION

Homeland Watchdog

Victor Drushlyakov

▲ A brand-new MiG-31 makes a pre-delivery test flight. The aircraft is unpainted, save for the ventral anti-glare panel required for checking out the IRST.

Another MiG-31 photographed during pre-delivery tests. The aircraft appears to be painted grey but the markings have yet to be applied. ▼

The new interceptor was particularly needed by the Soviet Air Defence Force units in the country's northern areas and in the Far East. The air defence situation in these areas had deteriorated considerably. The US Air Force's Lockheed SR-71A Blackbird reconnaissance aircraft had been intruding into the Soviet airspace (not least over the militarily sensitive areas of the Kamchatka Peninsula and the island of Sakhalin) for quite some time, and in the North they penetrated as deep as Arkhangel'sk, another area packed with sensitive military installations. The SR-71's great altitude of flight, coupled with the exceptionally high speed, made it virtually invulnerable. Surface-to-air missiles had practically no chances of hitting the high-flying Mach 3 reconnaissance aircraft. Infringement of the Soviet air space by the USAF aircraft stationed at Kadena AB in Japan and by US Navy carrier-borne aircraft also became more frequent. The MiG-23P and Su-15TM interceptors which formed the backbone of the Air Defence Aviation in the Far East were no match for the high-altitude super-fast SR-71s; nor could they oppose on equal terms the brand-new McDonnell Douglas F-15C Eagle, Grumman F-14A/D Tomcat and McDonnell Douglas F/A-18 Hornet fighters. Only long-range air-to-air missiles launched by a high-altitude, high-speed interceptor could hit the Blackbird and oppose other modern spyplanes at long distances. Consequently, the MiG-31 was vitally needed for protecting the areas beyond the Polar circle and in the Soviet Far East.

By the autumn of 1980, when the MiG-31's test programme was basically completed, the first production interceptors had already

Victor Drushlyakov

reached some first-line units of the PVO. However, the first units to receive the new interceptor were the training regiment of the PVO's 148th TsBP i PLS (*Tsentr boye**voy** podgo**tov**ki i pere**oo**chivaniya **lyot**novo sos**ta**va* – Combat Training and Aircrew Conversion Centre) at Savasleyka AB and the 786th IAP (*istre**bi**tel'nyy aviatsi**on**nyy polk* – Fighter Air Regiment) stationed at Pravdinsk; both locations were not far from Gor'kiy (now renamed Nizhniy Novgorod). It was in these units that the new MiG-31-33 aerial intercept system underwent service trials. In January 1982 the aircrews of the 174th *Pechengskiy* Red Banner IAP named after Boris F. Safonov (the honorary appellation was given for the unit's part in defending the city of Pechenga during the Great Patriotic War) started their conversion training. The regiment stationed, in Monchegorsk on the Kola Peninsula, had previously flown the Yakovlev Yak-28P, converting fully to the MiG-31 in 1983. In September 1983 the new MiGs also arrived in the Far East, namely Sokol AB on Sakhalin (not to be confused with the identically named international airport in Magadan, which is much further up north). In the fighter units of the Air Defence Force Aviation the MiG-31 supplanted the Su-15TM and the Tu-128, which were getting long in the tooth.

The regiments equipped with the new interceptors covered two directions of probable strikes by a potential adversary – the Northern and the Far Eastern directions. However, the first combat task to be tackled by the interceptors was counteracting the SR-71. The Blackbirds used a harassment tactic, intruding into Soviet airspace to a depth of several dozen kilometres and challenging the Air Defence System to undertake actions in response. The very short time spent by these aircraft over the territory of the USSR made it practically impossible to shoot them down by a surface-to-air missile; yet, the radar systems of the PVO were switched to combat alert mode, and the operational parameters of the systems were comfortably recorded by a US ELINT aircraft flying outside the Soviet Union's territorial limits.

Initially the introduction of the new intercept system into the USSR Air Defence units did not result in bringing down the number of flights of NATO aircraft along Soviet borders, yet the cases of these aircraft approaching the borders became less frequent. For example, before 1984 the pilots of the 365th (or possibly 777th) IAP, flying the Su-15TMs, proved impotent against the SR-71s; with the advent of the new Su-27P and the MiG-31 they quickly made the Blackbird crews realise it was best to stay away from the Soviet borders. As an example one can cite an intercept which took place on 8th March 1984: a pair of MiG-31s blocked an SR-71 so effectively over neutral waters that it had to return to base without fulfilling its assignment.

Gradually several other Air Defence Force fighter regiments were re-armed with MiG-31s. In the European part of the country the regiments were based at Amderma, Gromovo, Kotlas, Monchegorsk, Morshansk, Pravdinsk, Savasleyka AB, Arkhangel'sk-Talagi (which is both the city's principal airport and a fighter base) and Khotilovo AB. Conversion of the pilots took place at the 148th TsBP i PLS.

The first evidence about the 'MiG-25MP' interceptor had reached the West much earlier – as far back as 1976, when the notorious

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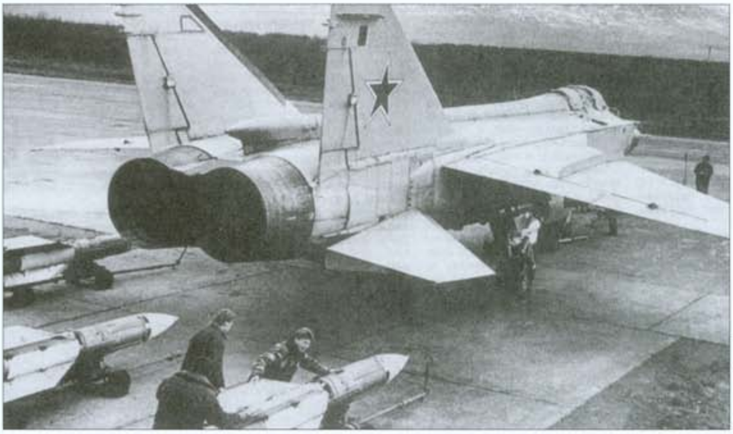
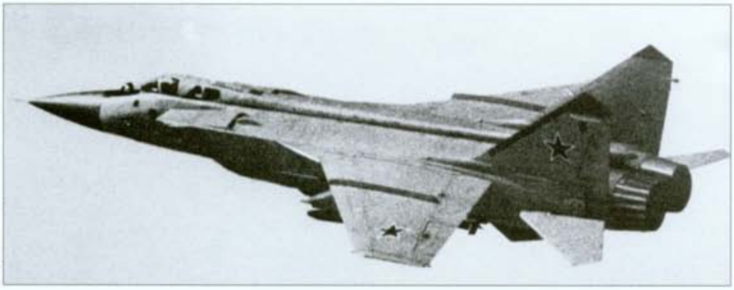
▲
A MiG-31 coded '36' is seen on approach to Gor'kiy-Sormovo, the factory airfield.

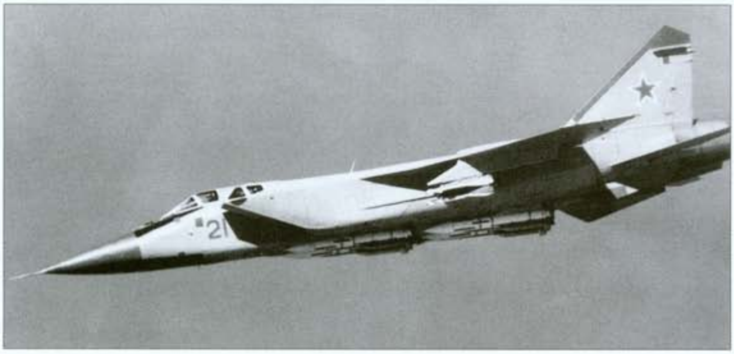
Armourers prepare to hook up R-33 missiles to an operational MiG-31.
▼



Krasnaya Zvezda


Royal Norwegian Air Force

Royal Norwegian Air Force


Royal Norwegian Air Force

defector Viktor Belenko said that the Mikoyan OKB was working on a two-seat version of this aircraft. Reliable information about the new interceptor's capabilities was not yet available, but, proceeding from the knowledge about the progenitor of this derivative, the new Soviet interceptor was tentatively allocated the NATO reporting name *Super Foxbat*.

In 1983 the US Department of Defense published three-view drawings of Soviet aircraft based on pictures received from surveillance satellites. Of all the provisional images of advanced Soviet combat aircraft that were published in Western magazines in the early 1980s, the '*Super Foxbat*' bore closer resemblance to the actual machine than the others. Some publications even surmised that the three-view drawing had been produced on the basis of far better-quality pictures obtained through intelligence agents rather than the satellite imagery. US satellites pinpointed at

◄▲

MiG-31 '24 Blue' was intercepted and photographed over international waters by the pilot of a Royal Norwegian Air Force/331 Squadron General Dynamics F-16A. This was the Western world's first face-to-face encounter with the *Foxhound*. Note the wake vortices streaming from the wingtips.

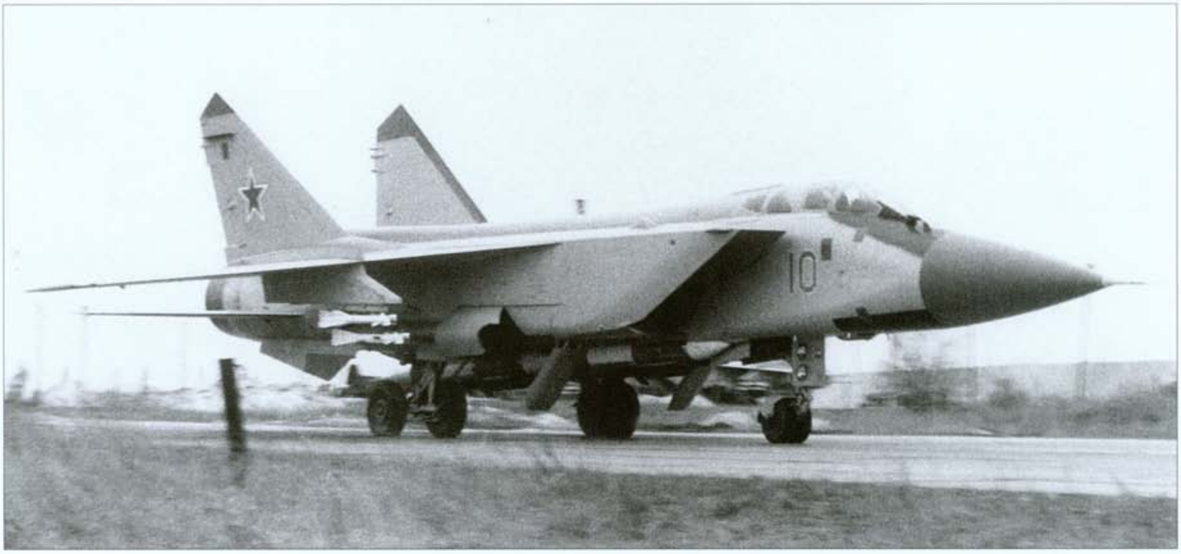
◄

Another picture of a MiG-31 over international waters taken from a shadowing Western fighter. This example carries a full complement of four R-33s and four R-60Ms.

MiG-31 '99 Blue' heads a line-up of several sister ships on the flight line at Pravdinsk. This was one of the first photos of the MiG-31 to be released by the Soviet media.

▼

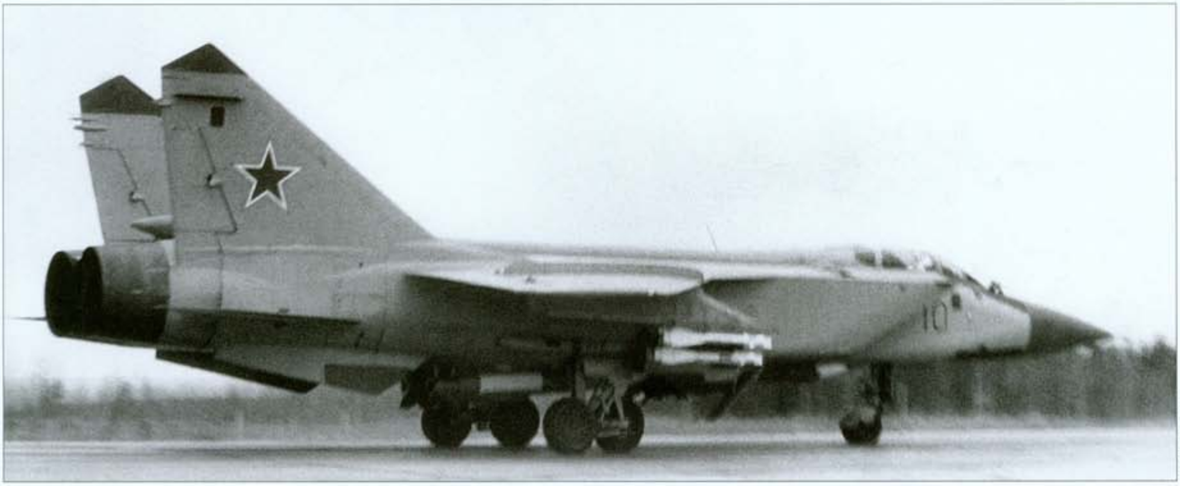
Krasnaya Zvezda



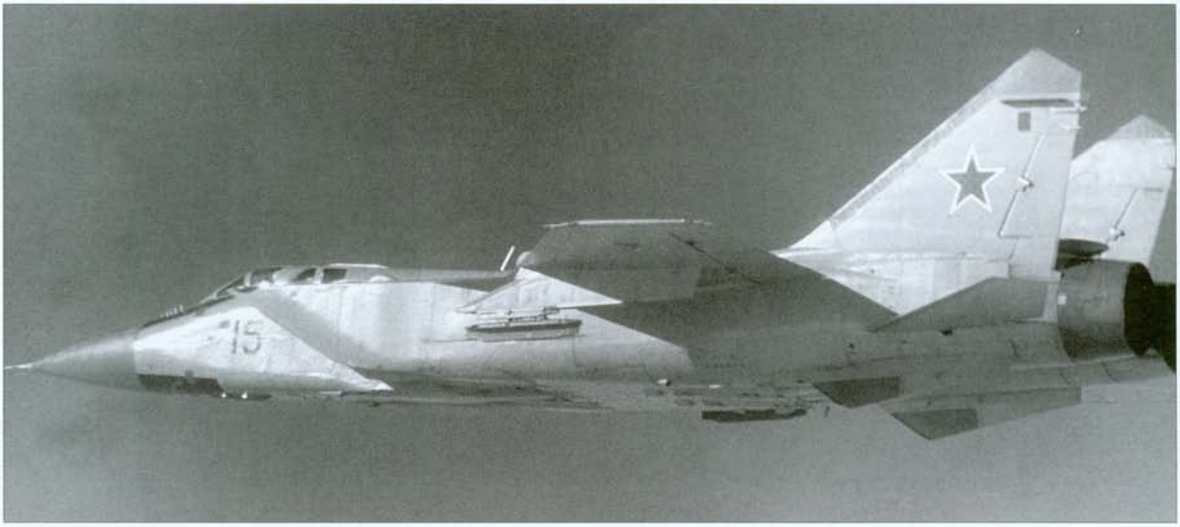
Nikolay Popov

▲ ►
An operational MiG-31 coded '10 Blue' taxies at its home base, again carrying a full weapons load of four R-33s on the fuselage hardpoints and four R-60Ms on APU-60-2 paired launchers on the wing pylons
▼

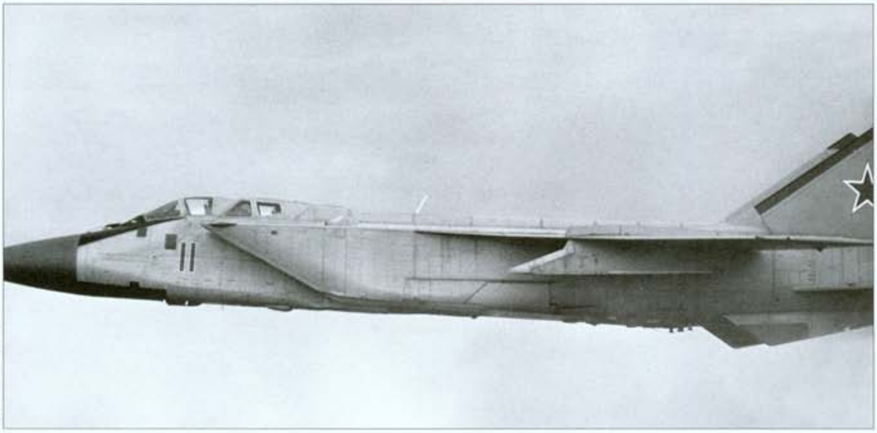
Nikolay Popov



Nikolay Popov



Via Nikolay Popov

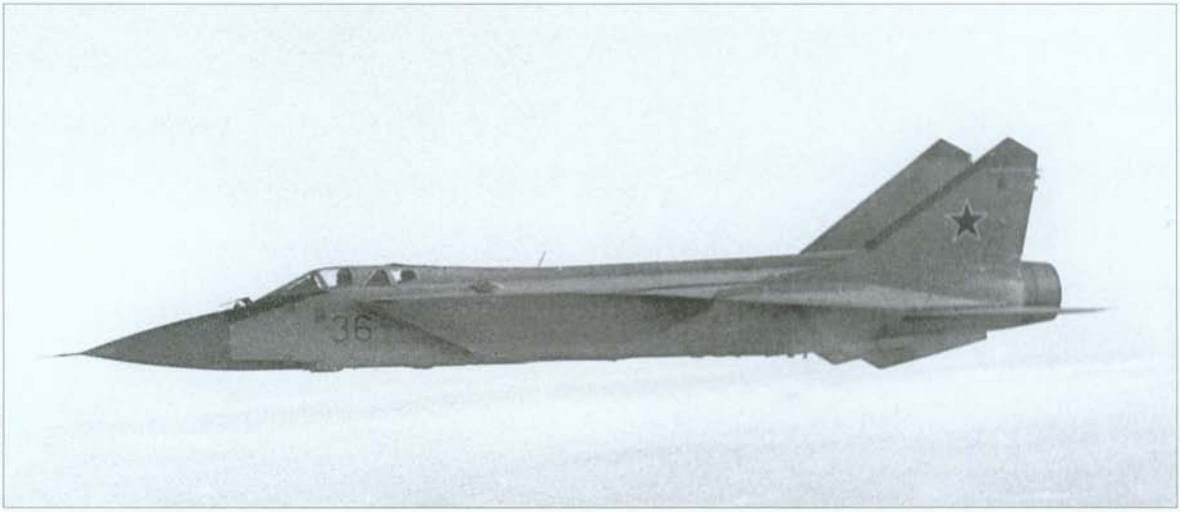


Via Nikolay Popov

▲
This air-to-air was made by 'friendlies', not NATO shadowers. This MiG-31 coded '15' carries only a pair of empty APU-60-2s.

◄
Another MiG-31 photographed from a sister ship.

MiG-31 '36 Blue' flies high above the clouds in 'clean' condition.
▼



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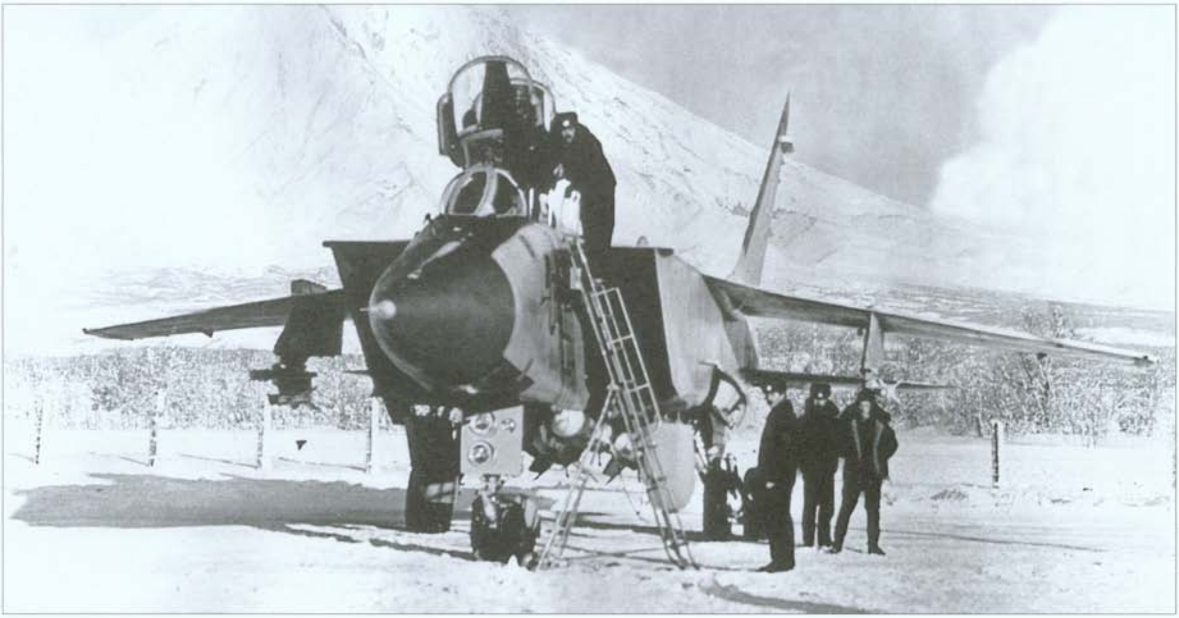

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least two intercepts of aerial targets simulating cruise missiles in the area of Akhtoobinsk, where the Red Banner Air Force Research Institute (GK NII VVS) was based. In one of the two cases the interceptor which was flying at an altitude of 6,000 m (19,680 ft) shot down an aerial target at an altitude of 300 m (980 ft); in the other case the target was flying at an extremely low altitude of the order of several dozen metres (less than 300 ft). Analysis of this information enabled experts to conclude that the new interceptor possessed considerably enhanced effectiveness as compared to the MiG-25P; its main mission was determined as the interception of low-flying targets with the help of long-range air-to-air missiles. In mid-1982 the '*Super Foxbat*' received the definitive reporting name *Foxhound*.

▲
With characteristic mountains in the background, a MiG-31 is serviced on a snowbound ramp. The aircraft is on quick-reaction alert duty, with a full set of missiles.

MiG-31 '01 Blue' sits in an earthen revetment at a wintry airbase.
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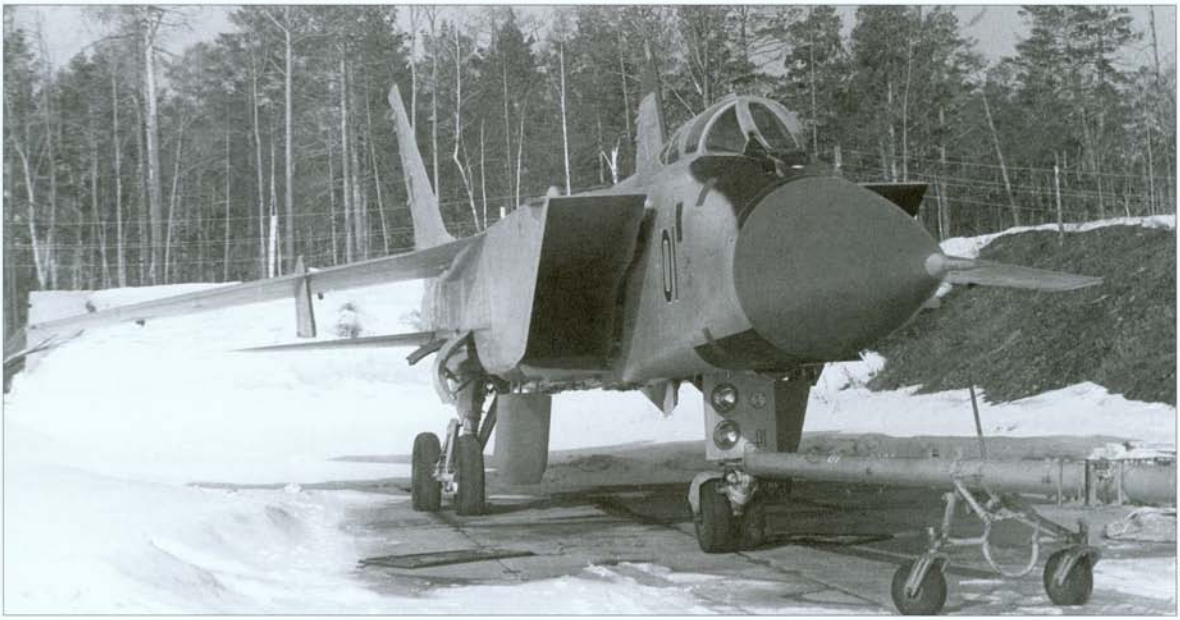

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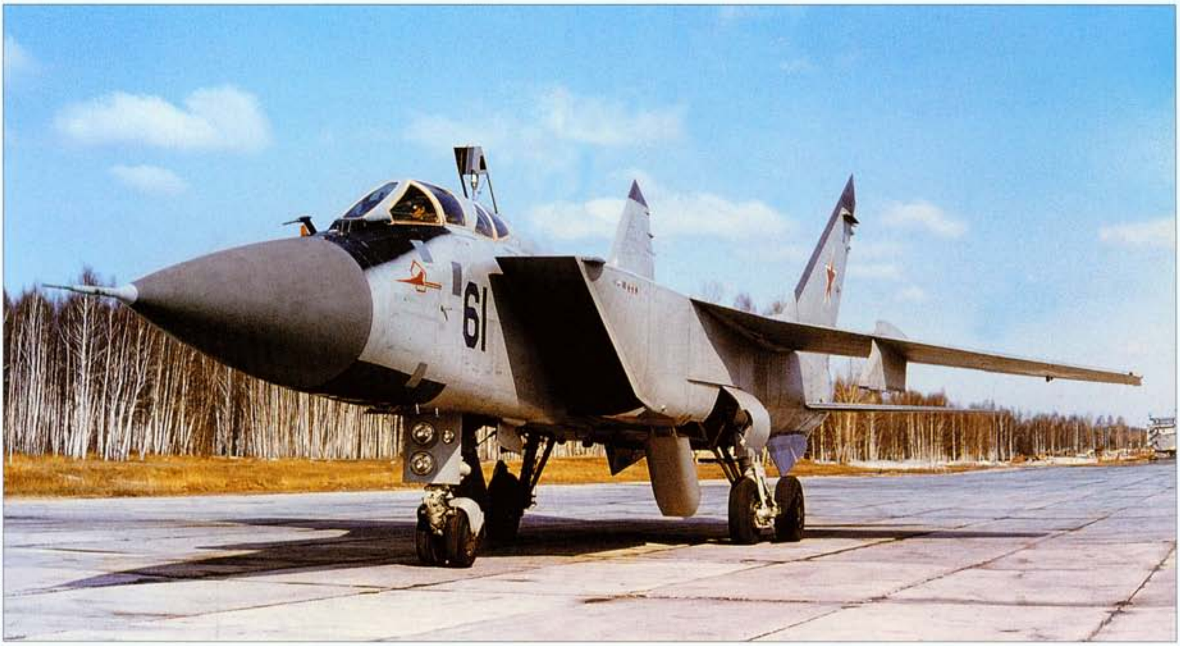
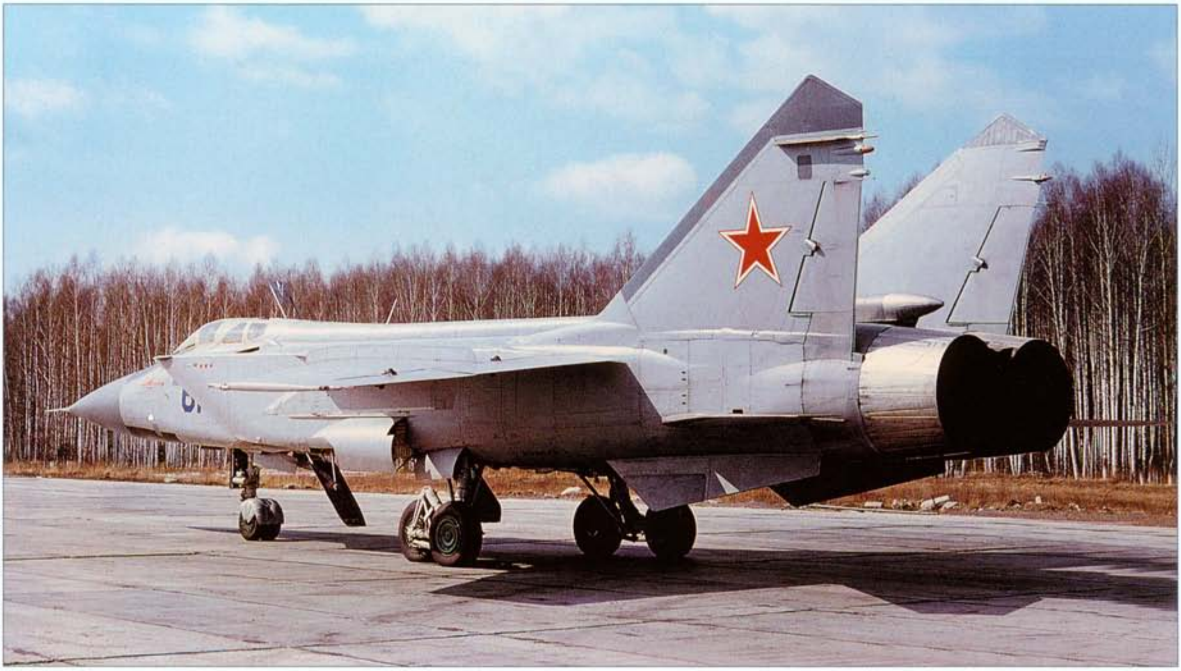


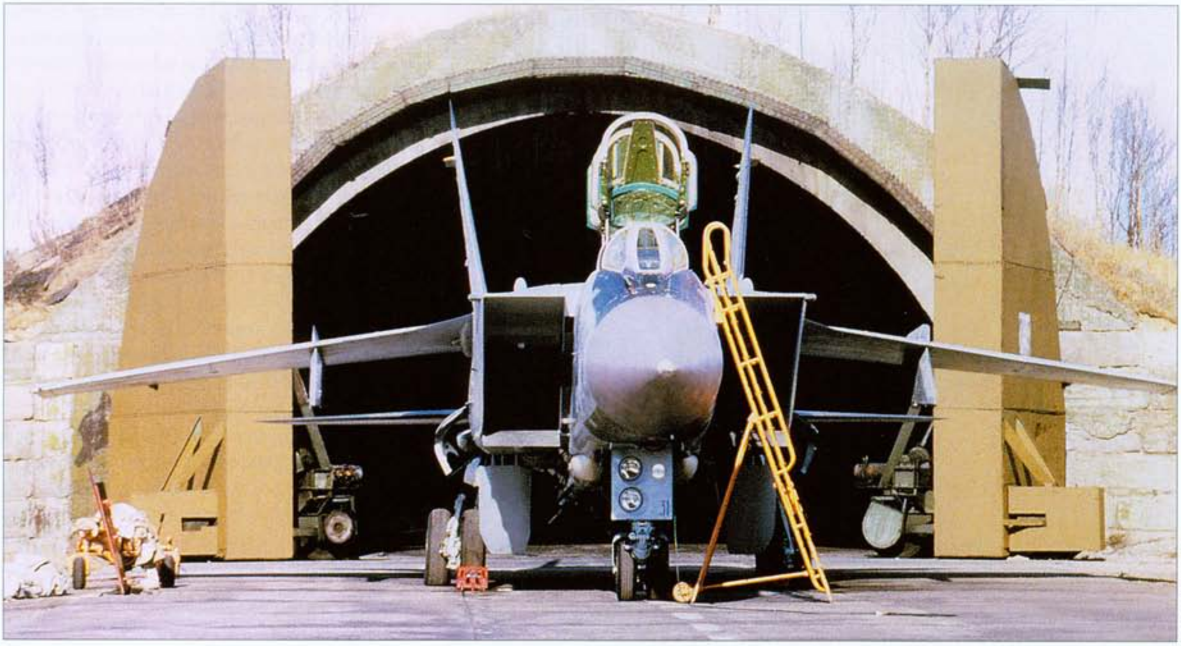
Tekhnika i Vo'orouzheniye

▲▼
Published in the mid-1980s by the *Tekhnika i Vo'orouzheniye* (Equipment & Armament) magazine, these were the first colour photos of the MiG-31 published in the USSR.

In the autumn of 1985 the MiG-31 was observed in Europe, too – the pilot of a General Dynamics F-16A Fighting Falcon fighter from the Royal Norwegian Air Force's 331st Squadron took photographs of the new Soviet interceptor over international waters off the coast of Eastern Finmark province of northern Norway. The photos were published in all the leading aviation magazines of the world and were accompanied by profuse comments. The Americans made no attempt to conceal that they were worried by the devel-



Tekhnika i Vo'orouzheniye



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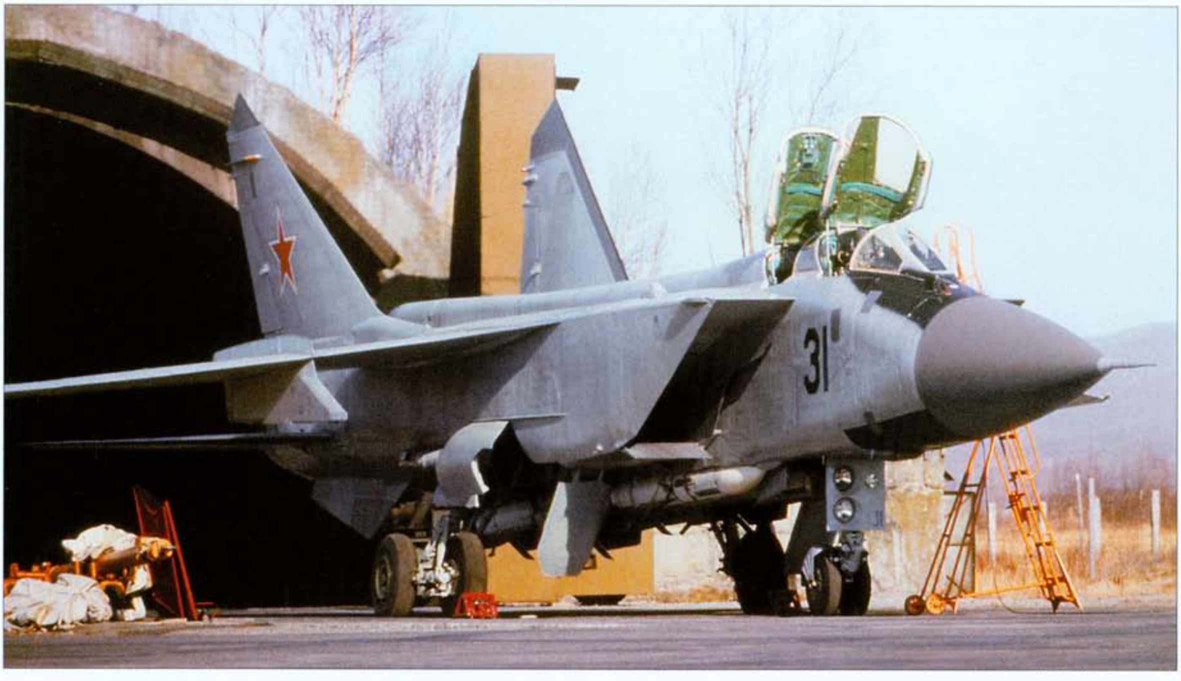
opment of new weapon systems in the USSR that could match the performance of their Western counterparts. Donald Lehman, US Deputy Defense Secretary responsible for command, administration, communications and intelligence, declared that the MiG-31 was superior to any US fighter, including the F-15, and had more capable avionics, including a better GCI guidance, control and communication system, better air-to-air missiles, and possessed greater speed and a longer combat radius.

▲

Coded '31 Blue', this probeless *Foxhound* sits in front of a hardened aircraft shelter (HAS) on a Far Eastern airbase. Note the thickness of the doors.

▼



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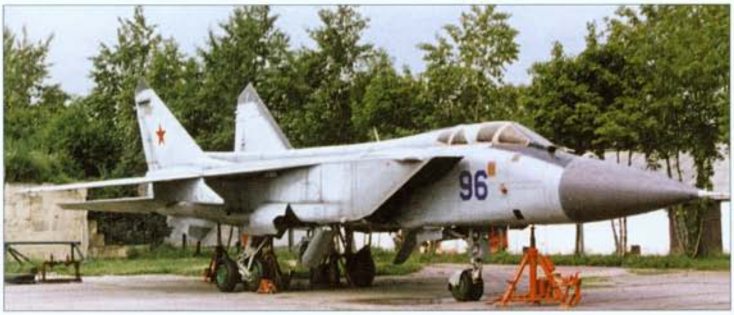
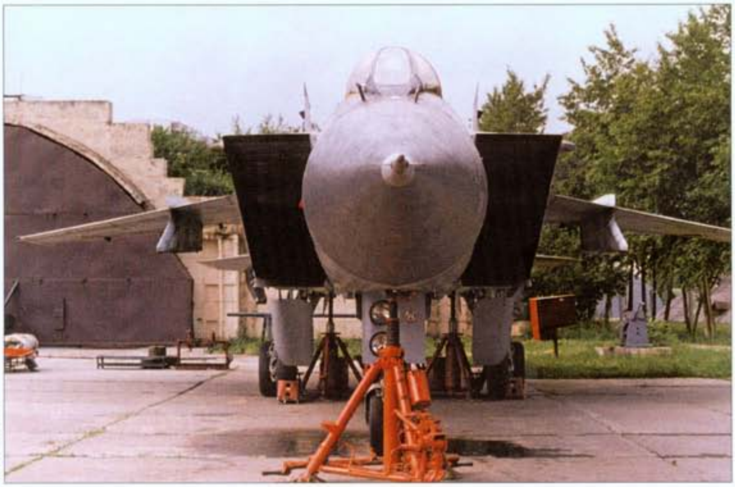

Yefim Gordon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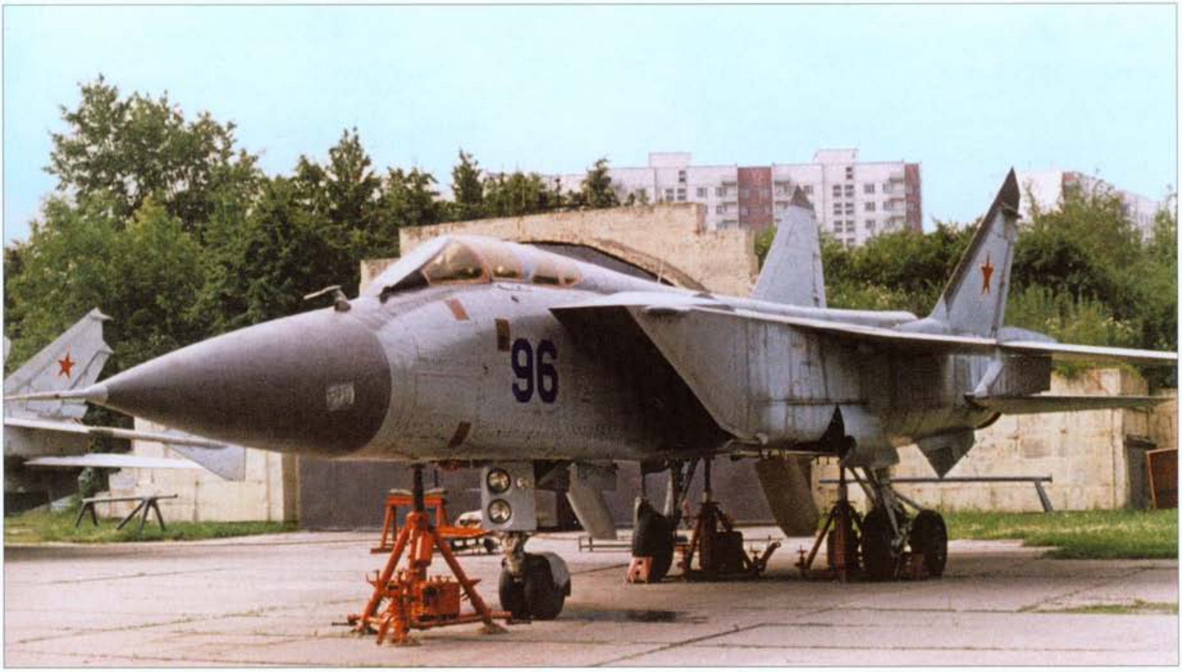
The intensity of the interceptors' operations peaked at the Far Eastern and northern borders of the USSR. This can be vividly exemplified by the statistics of just one PVO regiment based at Kamchatka, which converted to the MiG-31s early in the second half of the 1980s: in 1987 the regiment's pilots flew 214 missions to ward off reconnaissance aircraft, and in 1988 there were 825 such missions. Much nuisance was caused by SR-71s, Lockheed P-3 Orion anti-submarine warfare aircraft and Boeing RC-135 spyplanes. The area of the Kola Peninsula also constantly received the attention of NATO's intelligence services. In 1987 the pilots of the 174th IAP carried out 203 missions to accompany foreign aircraft that were flying along the Soviet border; this figure included 69 missions to repel the SR-71 reconnaissance aircraft operating out of RAF Mildenhall in the UK. In 1988 the intensity of the combat work further increased: there

◄ ▲

This early-production MiG-31 coded '96 Blue' (c/n N69700106125) served as a ground instructional airframe at the Junior Air Specialist School, a tech staff school in Solntsevo, a suburb of Moscow. Jacks are positioned below the aircraft for training the cadets in jacking procedures. Note the HAS in the background (the cadets had to be taught how to work inside them) and the very early MiG-25 with wing endplates.

▼


Yefim Gordon

were 436 missions (86 of them for intercepting the Blackbirds); in 1989 the number of intercept missions fell to 270. Apart from intercepting real targets, the pilots of the Monchegorsk-based regiment took part in various exercises, including the ***Sev**er-87* (North-87), *Otra**zhen**iye-88* (in his context, Rebuff-88) and others. In the course of these exercises the possibility of basing the operational MiG-31s at an ice-covered airfield on the Zemlya Frantsa Iosifa (Franz Josef Land) archipelago was tested.

Working alongside the aircrews of the 174th IAP were the MiG-31s from the Kem'-based 365th IAP and the Amderma-based 72nd GvIAP (*Gvar**dey**skiy istre**bit**el'nyy aviatsi**on**nyy polk* – Guards Fighter Air Regiment). The 72nd Regiment received its MiG-31s in December 1986, and on 27th May of the following year one of the regiment's squadrons went on combat duty on the new interceptors for the first time. That same day the first combat sortie was flown. A crew comprising pilot Guards Captain Yu. N. Moiseyev and WSO Guards Captain O. A. Krasnov

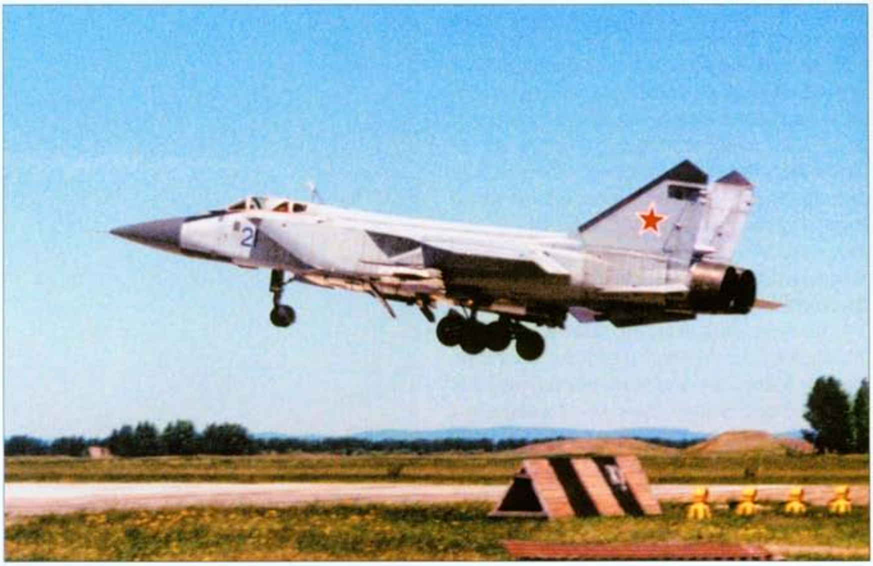
Sergey Skrynnikov

▲ **MiG-31s sit in front of their shelters at a dispersal area. The HASs were usually arranged in groups of three.**

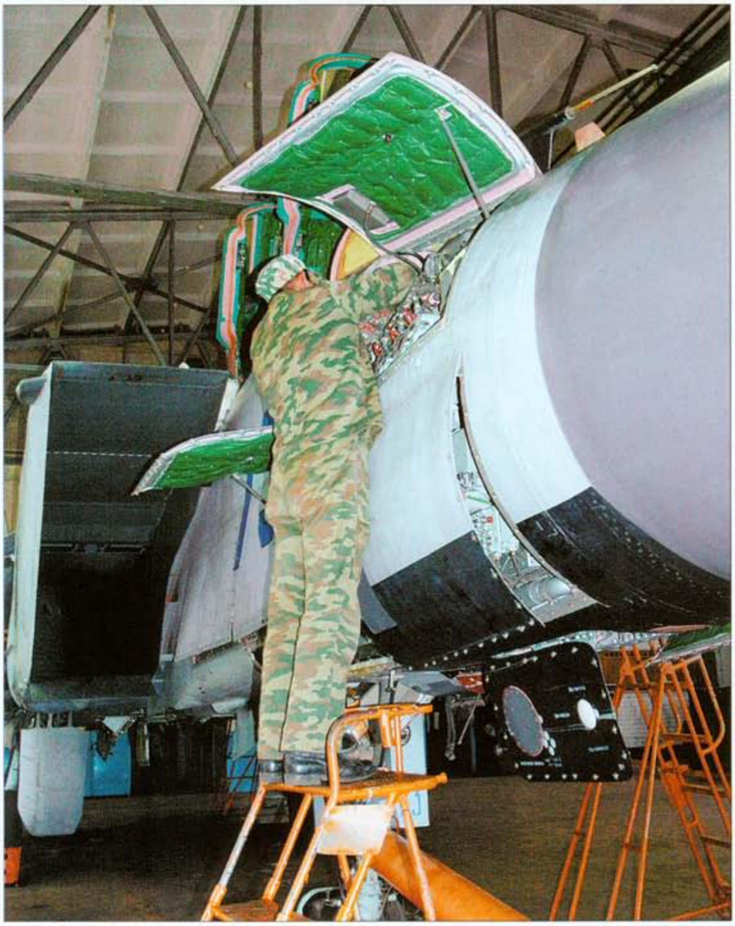
Wearing G-suits and GSh-5 full-face pressure helmets, the crew of this MiG-31 radiates confidence and experience. ▼

Sergey Skrynnikov

► Fully armed MiG-31 '21 Blue' takes off on a real-life patrol mission from a Siberian airbase. The high-tech aircraft makes a striking contrast with the very primitive runway markers made of planks that have probably been there for years; however, the base's navigation aids were obviously not all that primitive if such aircraft operated from there.


Via Nikolay Popov

A MiG-31 is 'unbuttoned' for routine maintenance at the regimental maintenance shop. Interestingly, the technician is wearing a camouflaged field uniform instead of the regulation black fatigues. ▼


Yefim Gordon archive

intercepted an SR-71 and prevented it from fulfilling its reconnaissance mission.

It would be untrue to say that Soviet pilots treated the MiG-31 with 'great respect'. Unfortunately, there were reasons for that. The loitering sorties were of long duration; in anticipation of this the designers had taken some steps to reduce the fuel burn. However, these steps and the acceptable specific fuel consumption of the engines did not solve the problem. Should one of the engines fail, the good engine began to guzzle so much fuel that range was drastically reduced. More often than not the loitering flights were performed over water expanses; Soviet fighter pilots were not accustomed to long-duration flights over the sea, and they often experienced psychological discomfort in flight. Powerplant reliability played a crucial role in this case.

However, there were also other reasons for the initial distrust towards the MiG-31. In comparison with its predecessors the MiG-31 proved to be rather strict in handling and disinclined to forgive pilot errors. Nonetheless, many pilots were not too zealous in studying the intricacies of the new hardware. Experienced pilots with a 'holier-than-thou' attitude showed no enthusiasm for conversion training. It was dangerous to fly the 'thirty-one' on the off-chance, yet, not all pilots and senior officers found it necessary to consult the flight manual.

Still, while some pilots mastered the new machine reluctantly, others were enthusiastic about it. The transition to the new machine proceeded rather smoothly in the air regiment stationed at Komsomol'skoye AB (1984) and in the Bratsk-based 350th IAP (1988-89) These were the so-called 'youth regiments' which were staffed to a considerable extent by recent graduates of flying schools who had not yet 'lost the knack' for learning. In addition, the successful mastery of the new interceptor by these regiments was facilitated, strange as it may seem, by geography: in the outback corners of the North and the Far East there was little else that might serve as a pastime.

The ground crews, too, were somewhat slow in getting accustomed to the new machine. After the 'medium-sized' Su-15TM, MiG-23P and MiG-25PD, the MiG-31 seemed huge and tall. Only technicians who had chanced to work on the Tu-128 were an exception: small wonder, since the *Fiddler* was dimensionally twice as big as the *Foxhound*. Russian aeronautical magazines cited an incident that happened in December 1988, when an unwary technician was sucked into an air intake.

The MiG-31 posed qualitatively new demands both for aircrews and for ground personnel; in consequence, operation of the aircraft was not free from accidents – both fatal and non-fatal – and incidents.

On 8th August 1988 a crew consisting of pilot Guards Major Kudryavtsev and navigator/WSO Kravchenko was flying a mission over the Barents Sea when a fire broke out in one of the engines. The efforts to extinguish the fire were not entirely successful, but the crew displayed exceptional nerve and presence of mind and brought the aircraft safely to base. The pilot and the navigator were awarded the Order of the Combat Red Banner and the order of the Red Star respectively. Sadly, in the summer of 1989 Major Kudryavtsev tragically lost his life during exercises while practising the use of R-33 AAMs.

Sergey Skrynnikov

▲
Out in the open in front of its shelter, this MiG-31 is readied for engine starting, with a ground power cart parked nearby.

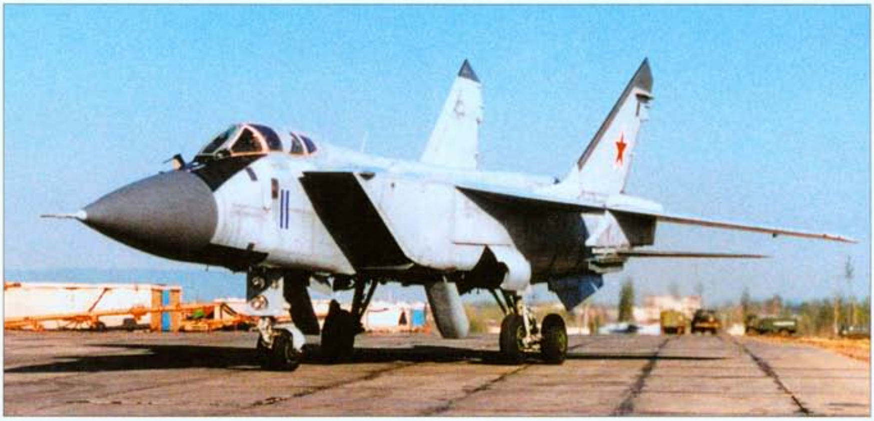
This immaculate MiG-31 was photographed at Kubinka AB west of Moscow. While the type was never based there, MiG-31s periodically visited Kubinka for demonstration to political and military bosses.
▼

ITAR-TASS

▶
MiG-31 '11 Blue' taxies out for a sortie. Soviet/Russian airbases are generally characterised by a poor-quality apron and runway surface.

Another view of '11 Blue'. Note the white stripes on the nosewheel used for checking that the tyre sits tight on the wheel disc.
▼

MiG-31 '33 Blue' taxies out for a proficiency training sortie. No missiles are carried, although a pair of APU-60-2s is fitted.
▼▼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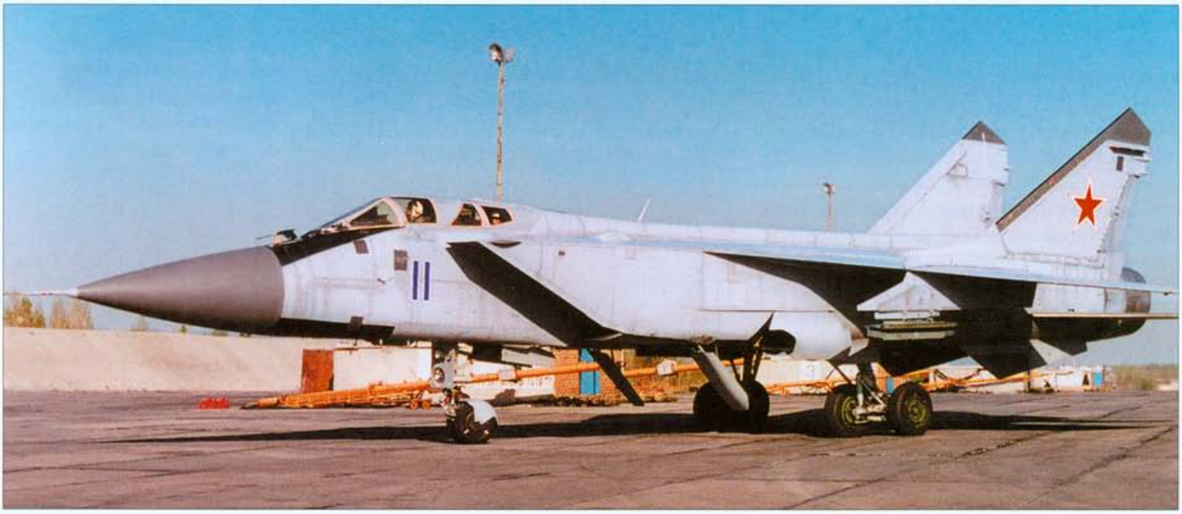
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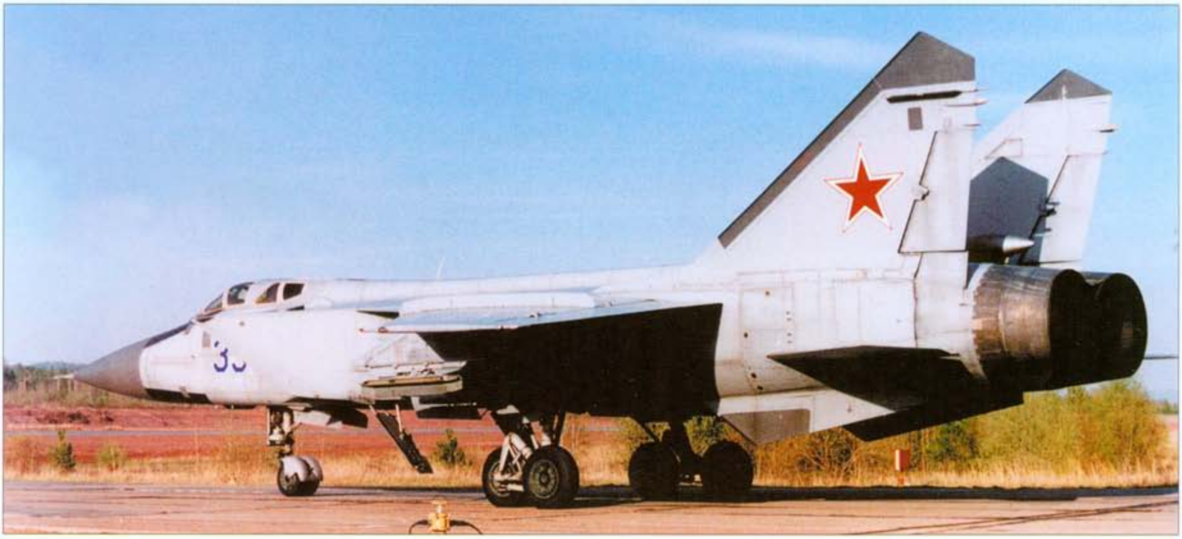
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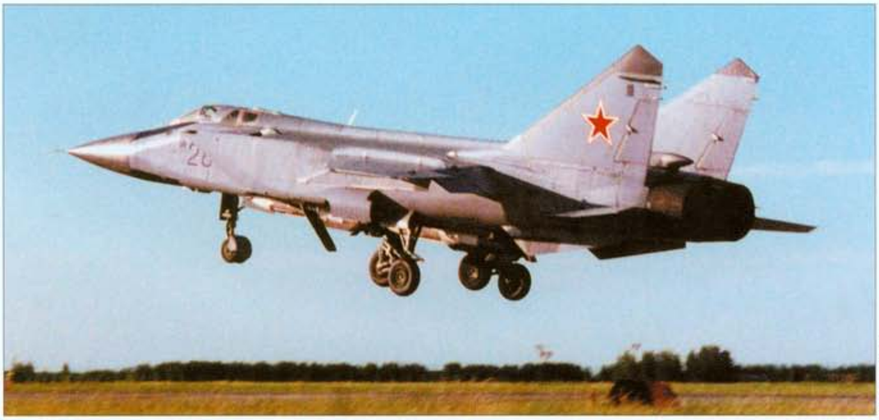
▶
Another *Foxhound* 'goes hunting', lit by the afternoon sun; the landing gear is just beginning to retract.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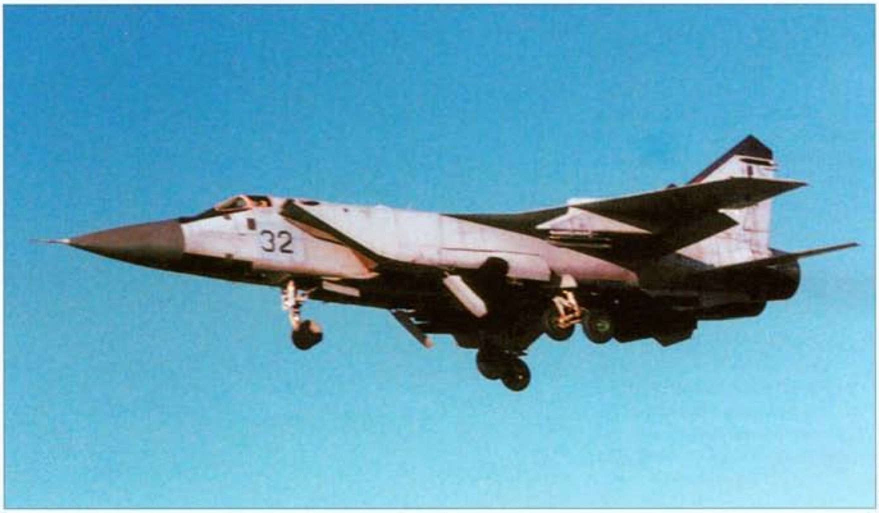
▶
MiG-31 '32 Blue' seen on short finals after a training sortie was previously operated by another unit and wore a different tactical code; the digits are clearly applied over a patch of lighter paint where the previous code had been painted out.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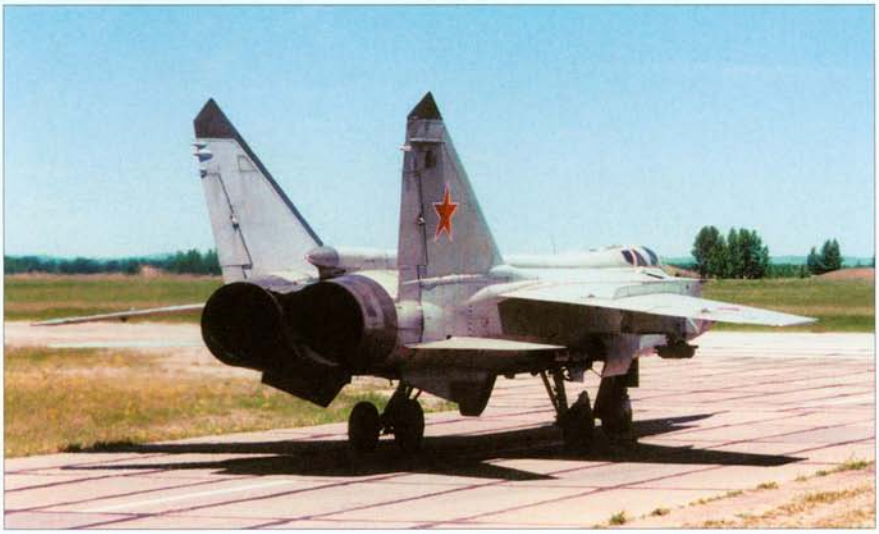
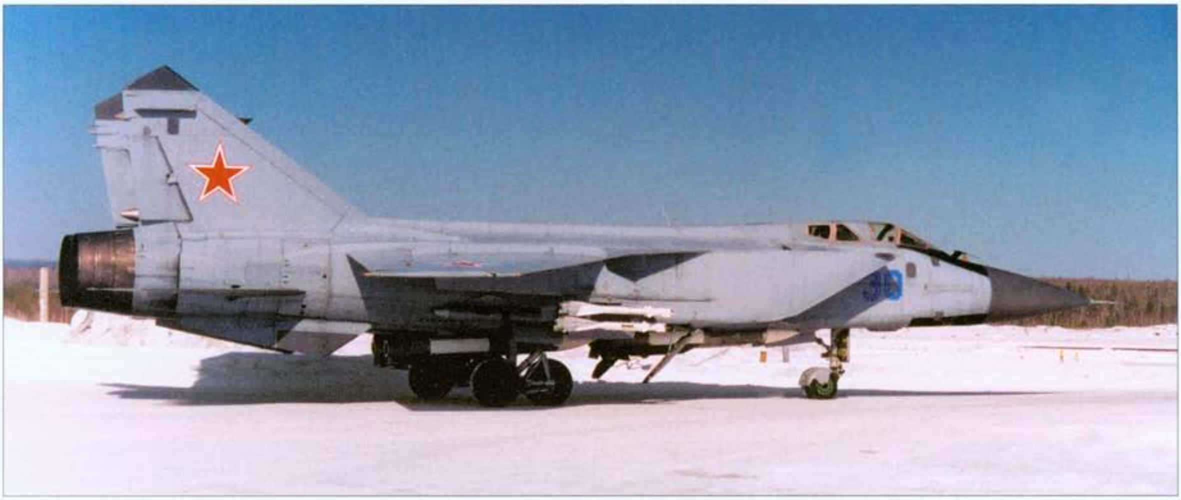
▶
This MiG-31 seen at the holding point, with the 'piano keys' of the runway immediately ahead, has an unpainted brake 'chute housing.

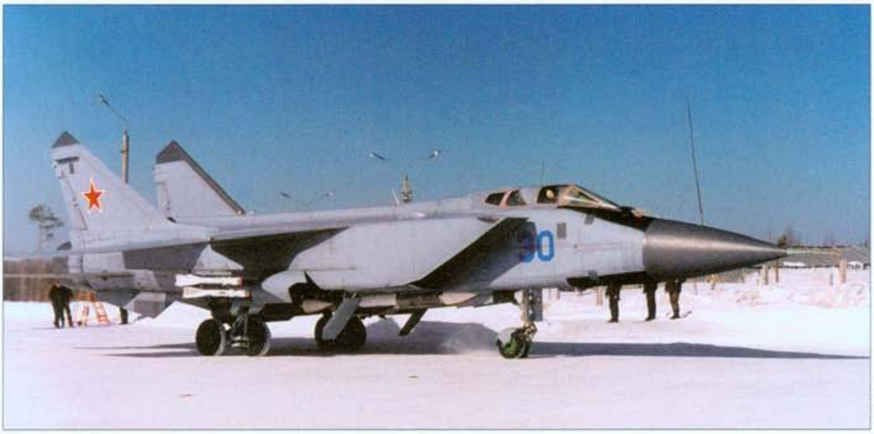

Nikolay Popov



Via Nikolay Popov

▲ ▶

MiG-31 '30 Blue' taxies at a Siberian airfield on a wonderful sunny winter's day. The aircraft carries a full complement of four R-33s and four R-60Ms.



Via Nikolay Popov

The same aircraft is prepared for a mission. Note that the snow has only been cleared from the spot on which the aircraft is parked; everywhere else the apron is absolutely covered with hard-packed snow.

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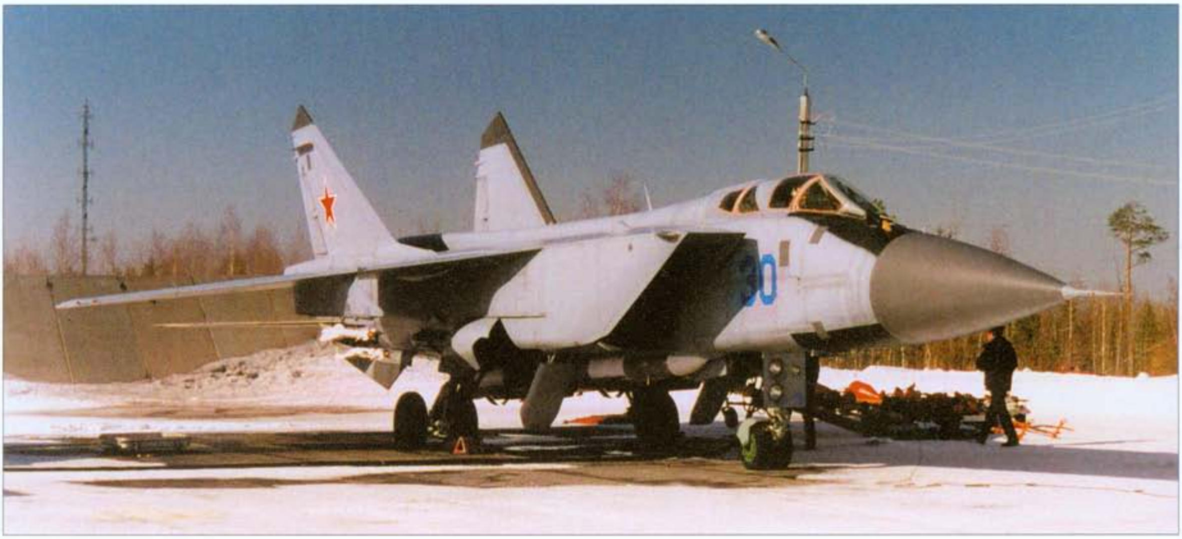
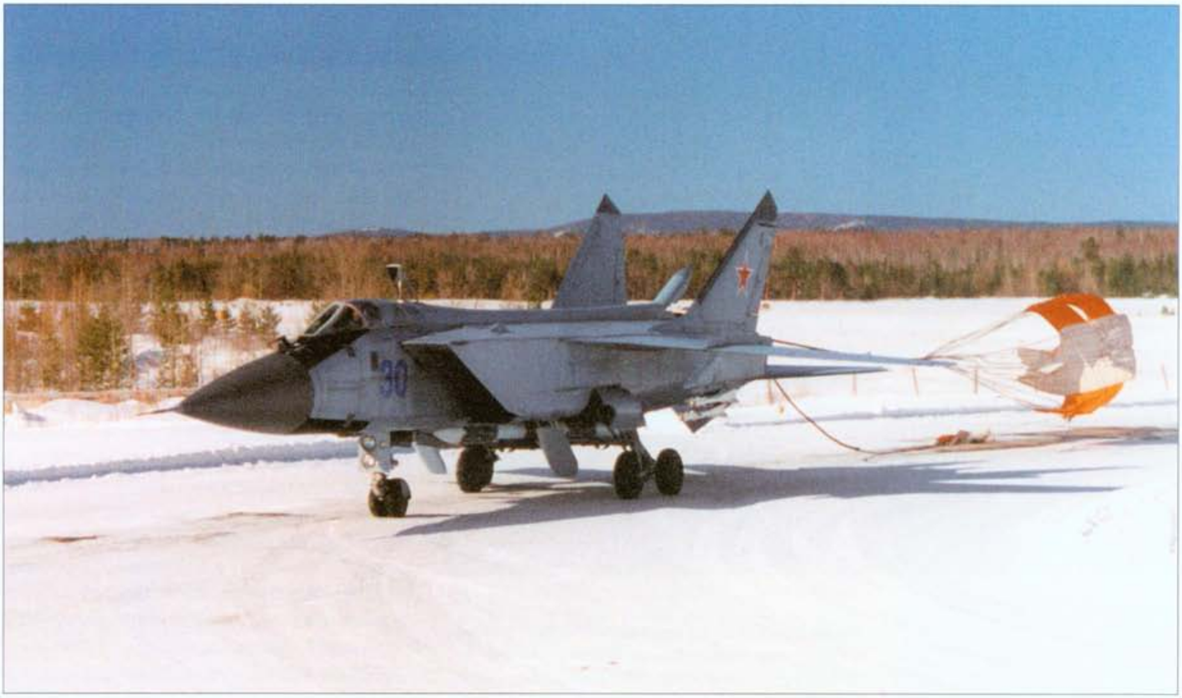


Via Nikolay Popov



Via Nikolay Popov

▲
MiG-31 '30 Blue' taxies in after the flight, streaming its twin brake parachutes. No missiles appear to have been expended this time.

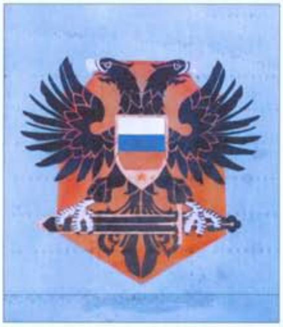
On 19th July 1989 a 72nd IAP MiG-31 coded '95 Red' (c/n N38400151519) crashed near Amderma airport (which was also the regiment's home base) at 1414 hours local time during a check-up flight after a biennial scheduled maintenance check. The aircraft had been manufactured on 3rd April 1987 and had logged 196 hours total time since new; there had been no overhauls.

Five seconds after the lift-off, as the undercarriage was retracted at 400 km/h (249 mph) IAS and an altitude of 25 m (82 ft), the warning system indicated a fire in the port engine. Flight control officer Lieutenant-Colonel V. S. Borisov noticed an unusual sheet of flame coming out of the port engine nozzle and gave orders to cancel the reheat. The pilot complied, throttling back the port engine to flight

Via Nikolay Popov

◄
Another view of the same aircraft after the parachutes have been released and recovered.

Vyacheslav Martyniuk



▲
Eleven MiG-31s on the flight line of the PVO Combat & Conversion Training Centre at Savasleyka AB. Only a few aircraft carry the unit's badge.

◄
The badge of the PVO Combat & Conversion Training Centre is based on the 'double eagle' featured on the Russian coat of arms.

To prevent the glazing from being damaged by the sun's UV radiation, the cockpit area is draped in tarpaulins when the aircraft sits parked for a long time.
▼

Vyacheslav Martyniuk

idle as soon as the minimum safe altitude was reached.

Two and a half minutes after the take-off the fire warning system indicated a fire in the starboard engine. When a further 30 seconds elapsed, the pilot shut down the port engine, closed the fuel shut-off cock and activated the fire suppression system. However, the thrust of the starboard engine running at full military power was already insufficient, and the indicated airspeed began to bleed off slowly. The pilot had to engage the afterburner of the starboard engine again, switching it off at a speed of 600 km/h (373 mph) and at an altitude of 670 m (2,120 ft).

After that the airspeed began to drop again, this time at a much higher rate. Attempts to engage the afterburner again were of no avail. At a speed of 340 km/h (211 mph) and at an altitude of 520 m (1,705 ft) the crew (pilot Guards Captain Nikolay V. Kravtsov, deputy squadron commander; navigator/WSO Guards Captain M. A. Gorboonov) was compelled to eject to safety; the aircraft dived into the ground and exploded.

Examination of the wreckage showed that the fire was caused by a fuel leak in the port engine bay as a result of faulty repairs. When the fuel piping dismantled for the purpose of replacing a fuel flow regulator was being put in place again, a sealing gasket was damaged; after engine start-up the fuel pressure blew the gasket. When the port engine was shut down, the flame from it was sucked into the starboard engine bay due to air ejection and pressure differential. The fire heated the cables controlling the convergent-divergent nozzle, causing an uncommanded opening to maximum aperture setting and, as a consequence, loss of thrust at full military power. The pilot failed to grasp what had happened and did not make use of the emergency nozzle closing feature; as a result, the speed fell below the minimum control value.

As a matter of fact, most of the problems on the MiG-31 were associated with the powerplant. The designers succeeded in reducing the engines' operating temperature to virtually half of the value typical of the MiG-25, yet engine fires did occur. Initially it was the cooling turbines that were at fault. They had caused no problems on the development machines, but in series production the factory started turning out turbine blades of inferior quality. With the turbine operating at 40,000 rpm, the blades broke off and wrought havoc in the engine bay, causing a massive fire. The cause of these fires could not be determined for a long time: as a rule, all that remained of the crashed aircraft was a big crater. A stroke of luck helped solve the problem. In Priozyorsk a fire broke out when a MiG-31 was beginning its take-off run. The flight control officer was quick in ordering the pilot to abort the take-off. The aircraft overran the runway and was destroyed by the fire, but what little remained of it enabled the investigators to trace the cause of the fire to the cooling turbine with its defective blades. This unit was then modified by installing armour plating which could not be pierced by the runaway blades. Later a cooling turbine of an all-new design was installed.

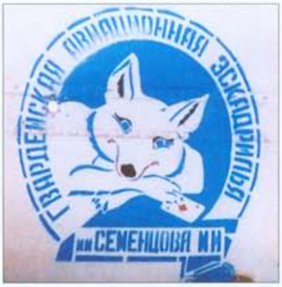
After the introduction of in-flight refuelling capability on the MiG-31 (*izdeliye* 01DZ) and MiG-31B the flight endurance came to be limited not by the hardware but also by crew fatigue which caused the airmen to be less attentive and made it difficult to carry out the mission effectively. Moreover, during a flight of such a long duration, elementary physical necessities of the crew members could prevent them from fulfilling the task. Nobody had given thought to this in the USSR, but even a crewman's need to relieve himself could provoke a flight incident or accident. However, persistent shortage of fuel in the units and the resulting low number of flight hours logged in the fighter air regiments made it possible to forget about this problem for a while.

Nevertheless, notwithstanding the fuel shortage and low flight hours logged by aircrews, the Russian MiG-31s continued flying combat patrol missions. For example, in 1994 a crew comprising Major A. N. Pshegoshev and Captain V. V. Velichko from a fighter unit based at Yelizovo airport, Petropavlovsk-Kamchatskiy, prevented an infringement of the state border by a US-registered Cessna 550 Citation II business jet.

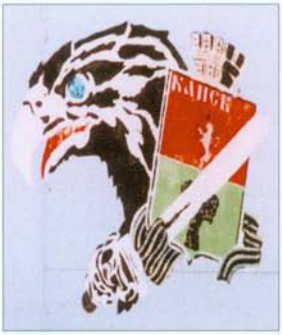
Slackening of control and failure to conduct timely repairs of the hardware resulted in incidents and crashes also in the 'post-*perestroika*' period when the pilots had considerably fewer opportunities to practise their flying skills than before the restructuring.

On 10th March 1993 a MiG-31 interceptor based on Kamchatka suffered an incident during a night flight at an altitude of 11,000 m (36,080 ft).

On 31st May 1995 a MiG-31 crashed in the vicinity of Komsomol'sk-on-Amur, on the right-hand bank of the Amur river. Immediately after take-off a fire broke out in one of the engines; the crew succeeded in getting the machine safely away from a residential area and then ejected safely.

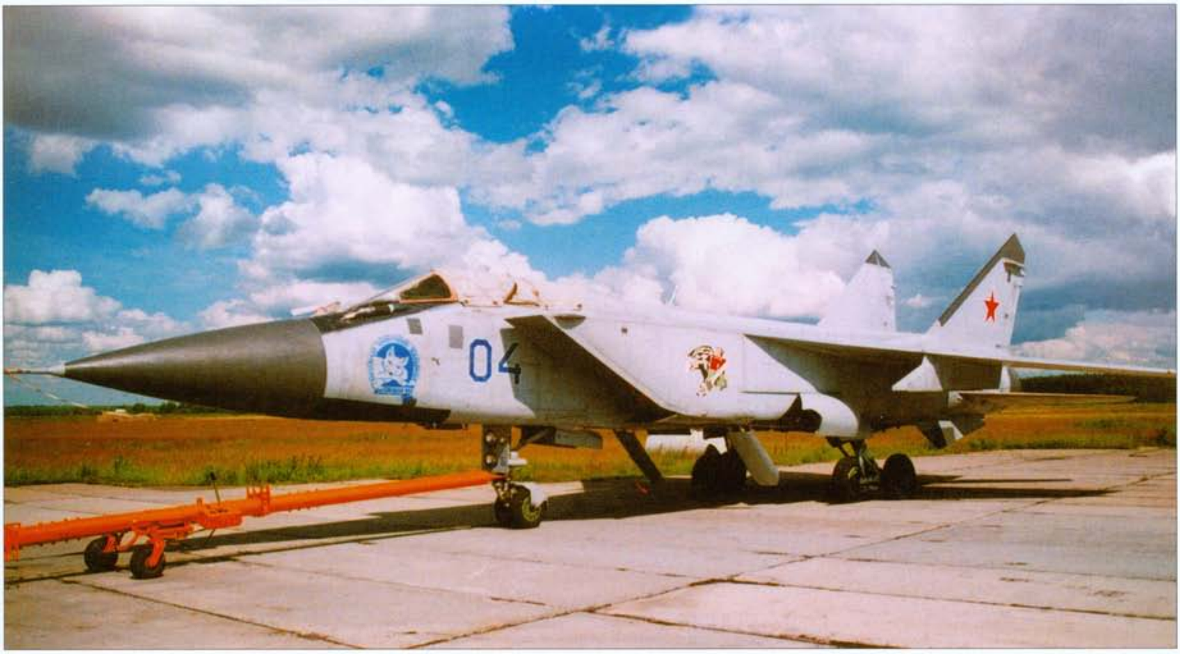


▲
The badge of the said squadron – a fox with an ace of diamonds. Such nose art was generally frowned upon.

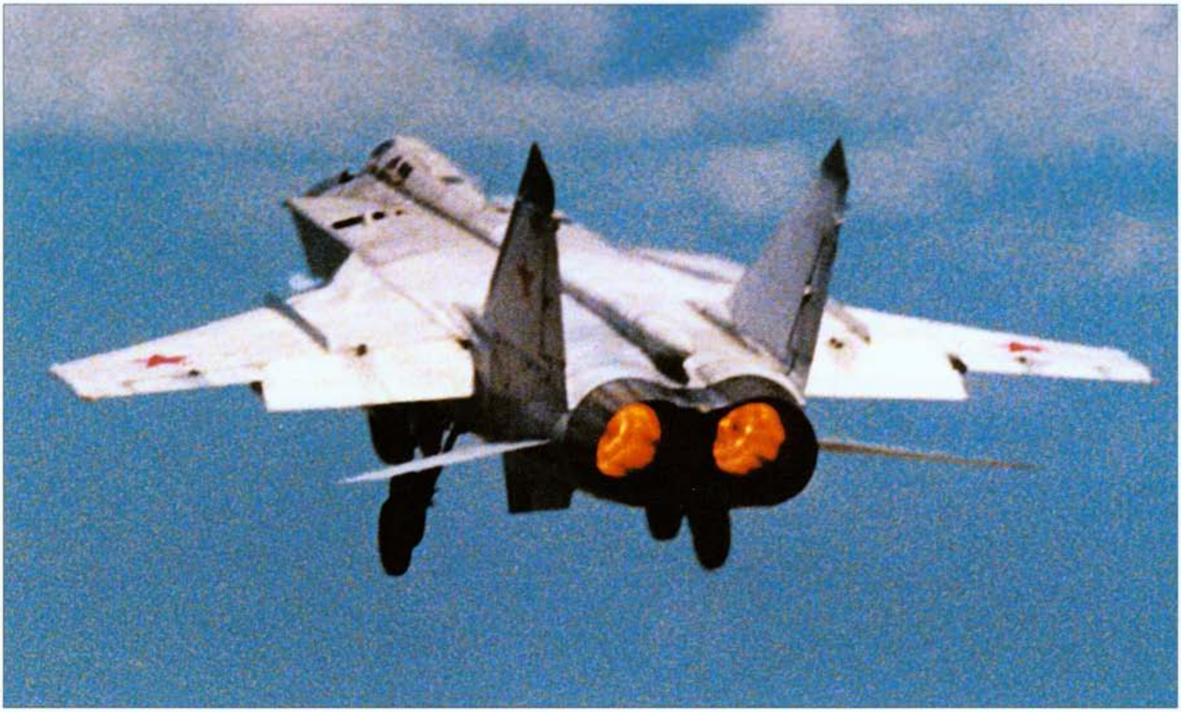


▲
Another unit badge worn by the same aircraft; the eagle holds the slightly altered city crest of Kansk.

More artwork on a MiG-31. This aircraft visiting Savasleyka AB belongs to the Guards Air Squadron named after M. N. Sementsov and based in the Siberian city of Kansk. ▼



Vyacheslav Martyniuk



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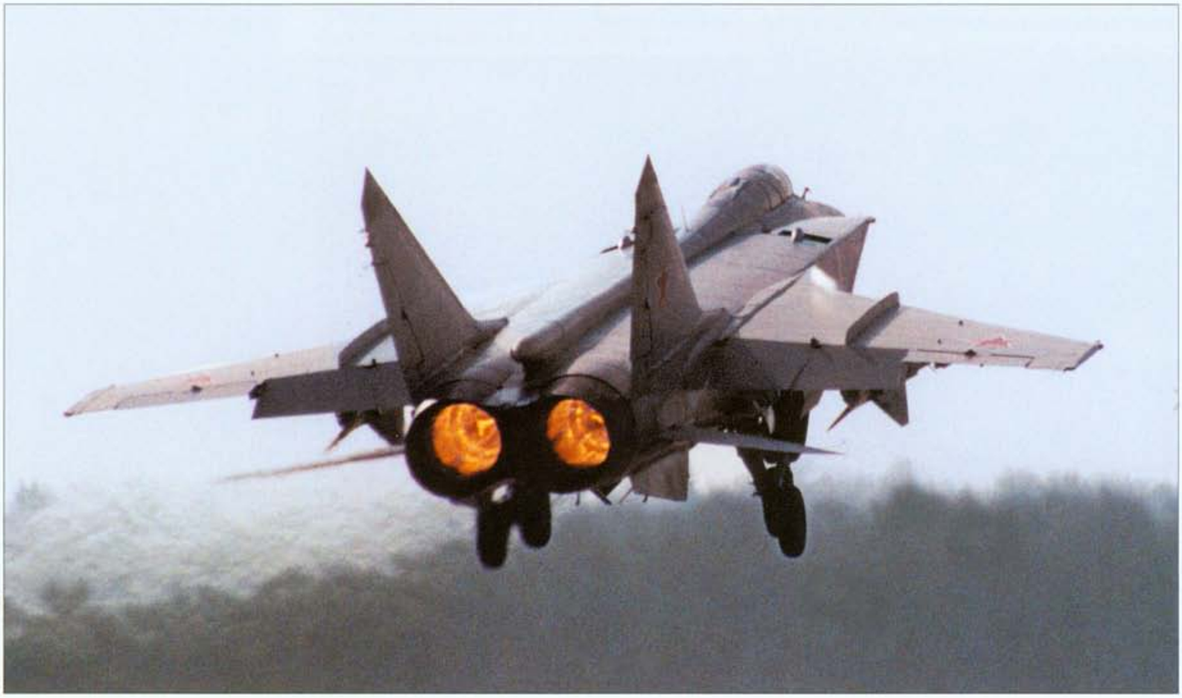
▲
A MiG-31 climbs away, showing the juicy afterburner flames and creating a tremendous racket.

Another fine take-off shot. Note the flaps set for take-off and the open auxiliary air intake doors.
▼



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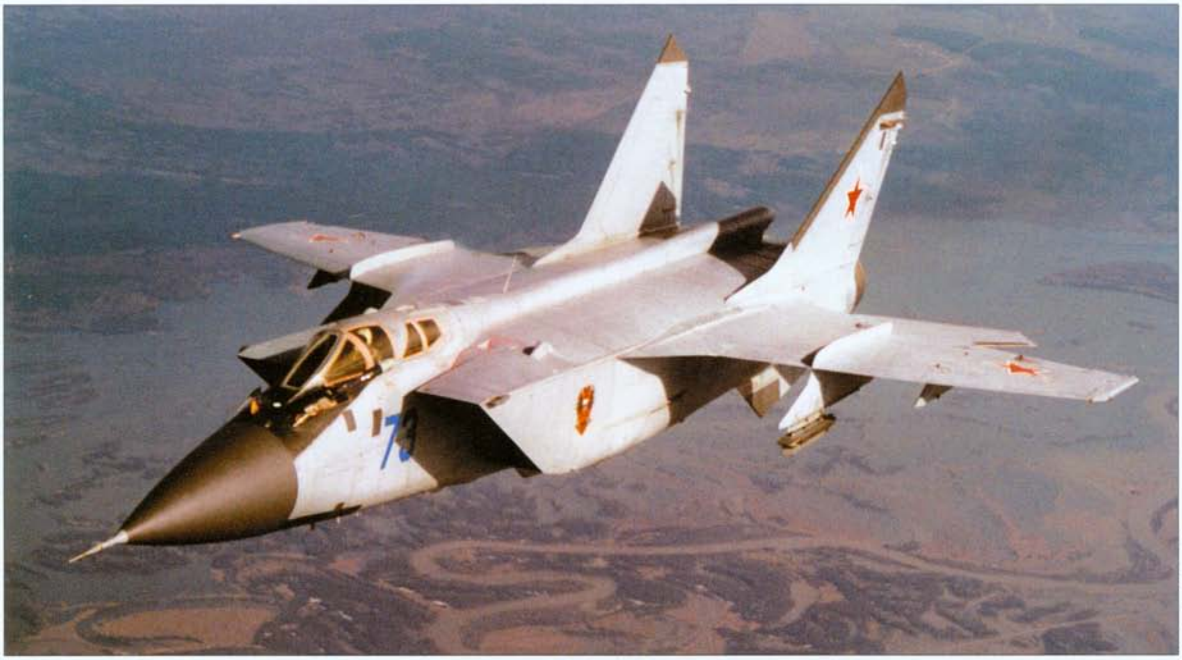

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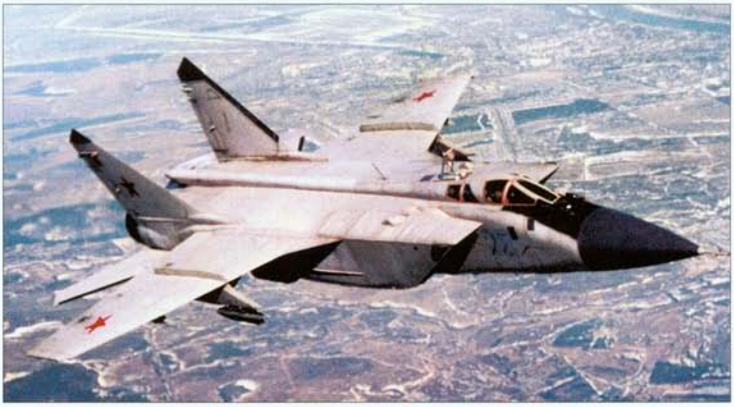
▲
The training centre at Savasleyka does a lot of flying on the MiG-31 – and, apart from training, it flies actual combat duty as well, protecting Moscow. The unit's IFR-capable MiG-31Bs are mostly coded in the 7x range. Note the light blue shade of the tactical code on '73 Blue'.



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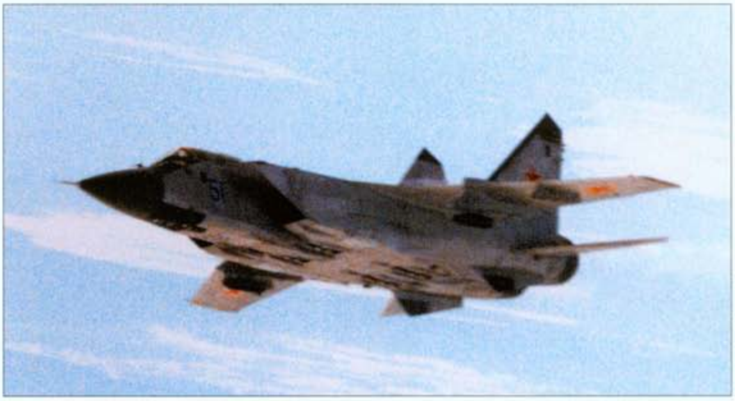
►
Another MiG-31B from Savasleyka, '72 Blue', cruises high above the Russian countryside near Nizhniy Novgorod. Training missions were normally flown in unarmed configuration.



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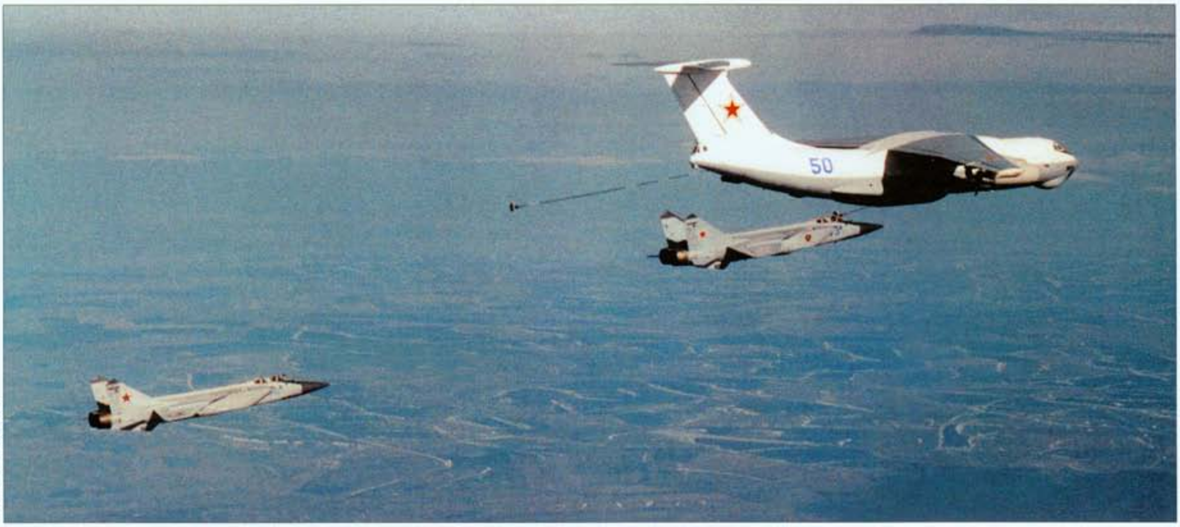
►
Several MiG-31Bs operated by the same unit have codes in the 5x range. On this aircraft the second digit is partly obliterated by weathering, making identification impossible.



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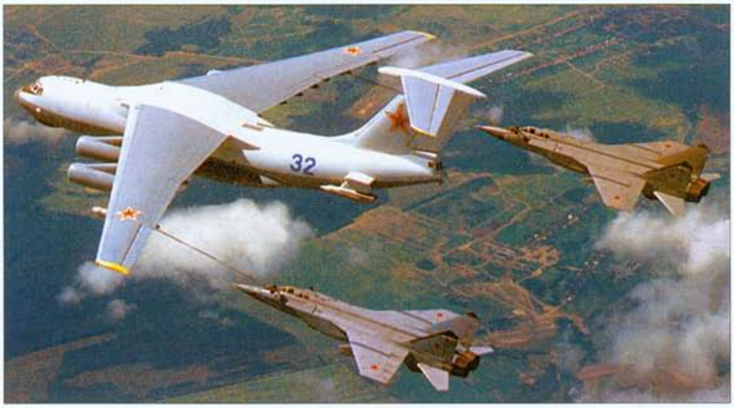
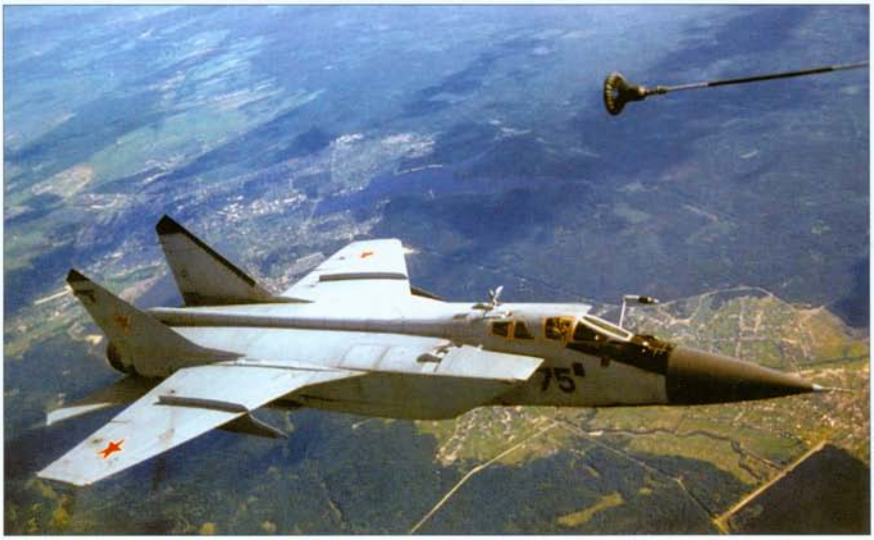


Voyeninform Press Agency

▲
The leader of this pair of MiG-31Bs has made contact with the starboard drogue of an Ilyushin IL-78M three-point refuelling tanker ('50 Blue', c/n 1003403068, f/n 7707), while his wingman prepares to engage the port wing drogue.

◄
The IL-78 (illustrated here by another IL-78M, '32 Blue', c/n 1003403079, f/n 7710) can refuel two tactical aircraft at a time. The centre UPAZ-1M pod with a higher delivery rate is used for refuelling heavy aircraft.



►
MiG-31B '75 Blue' about to 'hit the tanker' is seen here from the aerial refuelling system operator's station of an IL-78M. The black and white stripes on the hose are each 1 m (3 ft 3 in) long, serving to show how much of the hose has been paid out.

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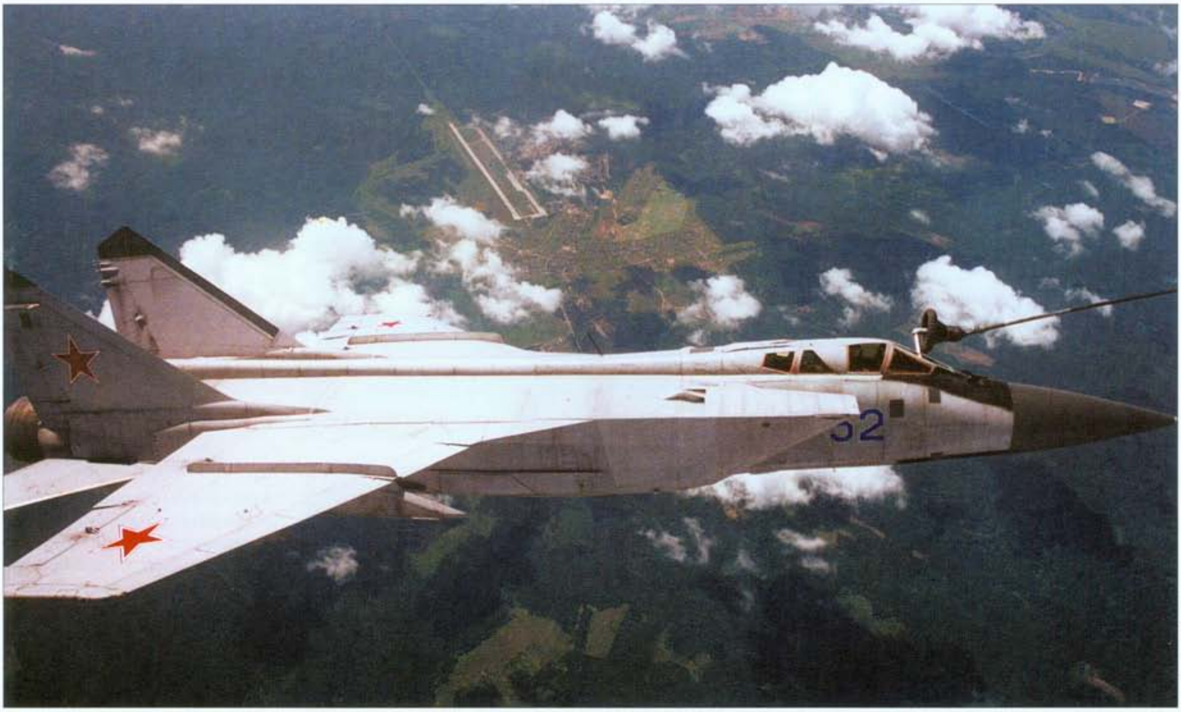

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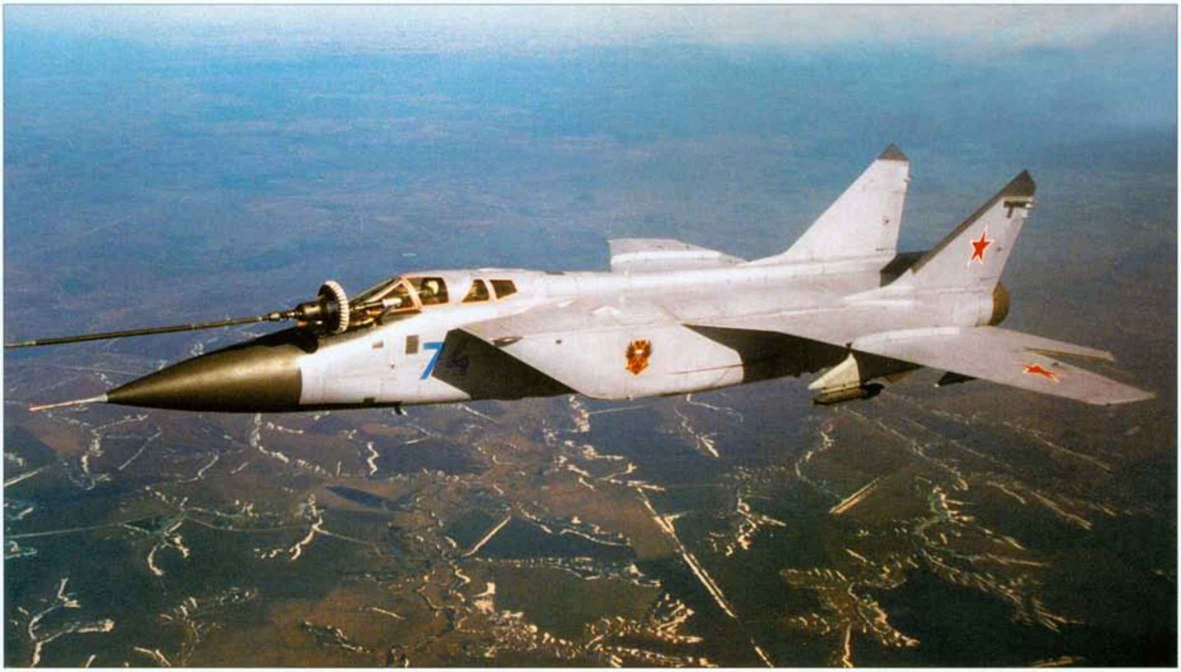
▲
MiG-31B '52 Blue' takes on fuel from the port UPAZ-1A pod of an IL-78M. Note the runway of 'hometown' (Savasleyka AB) visible above the aircraft.

'74 Blue' is caught by the camera a second before it makes contact with the drogue.
▼



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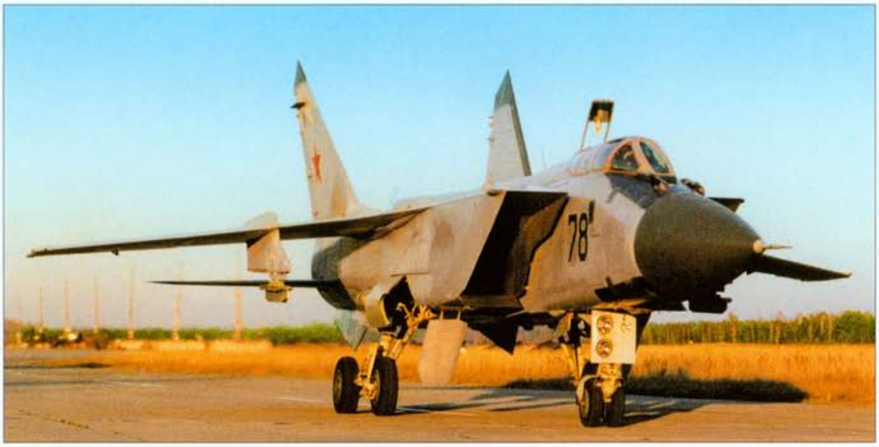

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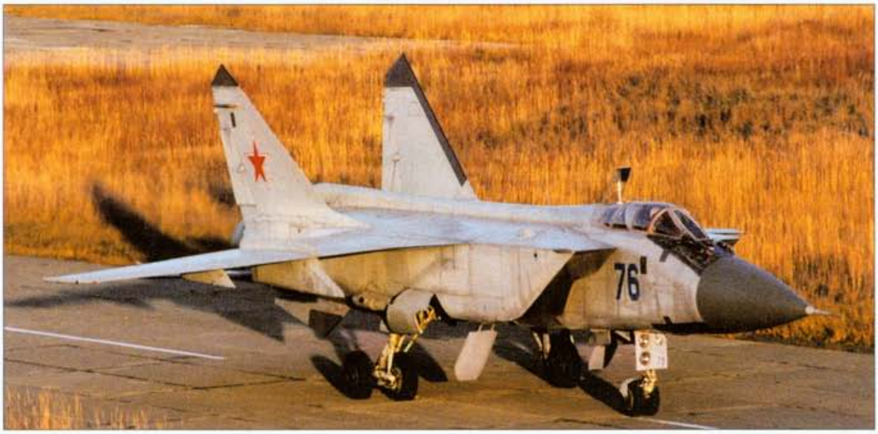
◄

MiG-31B '78 Blue' taxies out for an afternoon sortie at Savasleyka.



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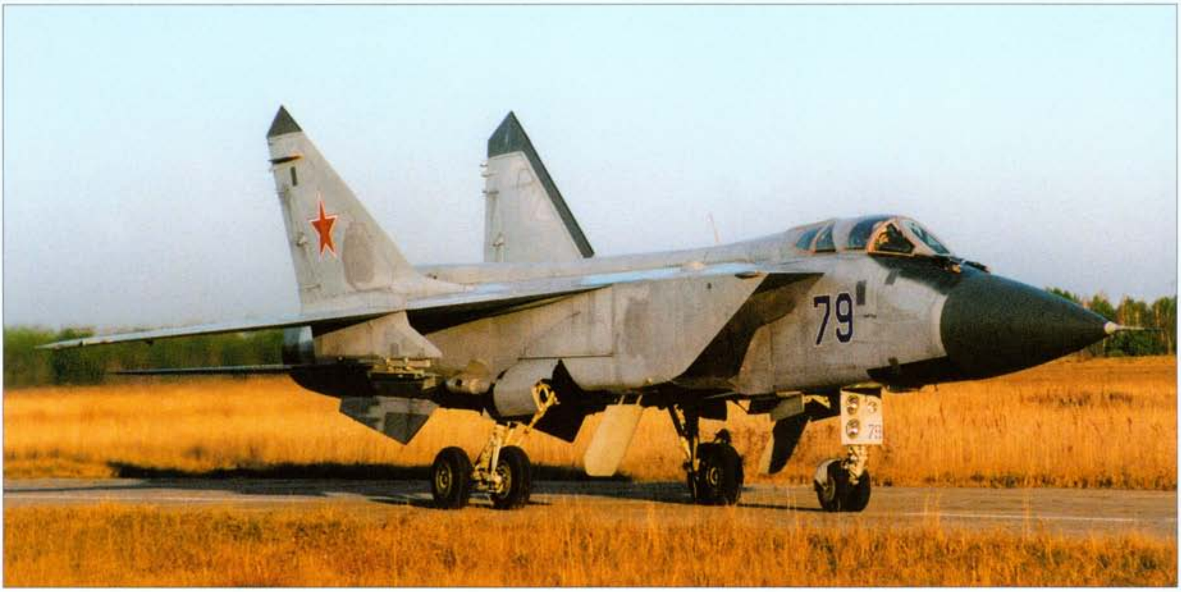
◄

Another sunset shot at the same location. Like most of the *Foxhounds* operated by the Savasleyka unit, '76 Blue' has the tactical code repeated on the nose gear door.

Most of the MiG-31Bs based at Savasleyka have the tactical codes applied in a darker shade of blue (appearing almost black in the failing afternoon light. Note the blotch on the fin where some artwork has obviously been painted out.

▼



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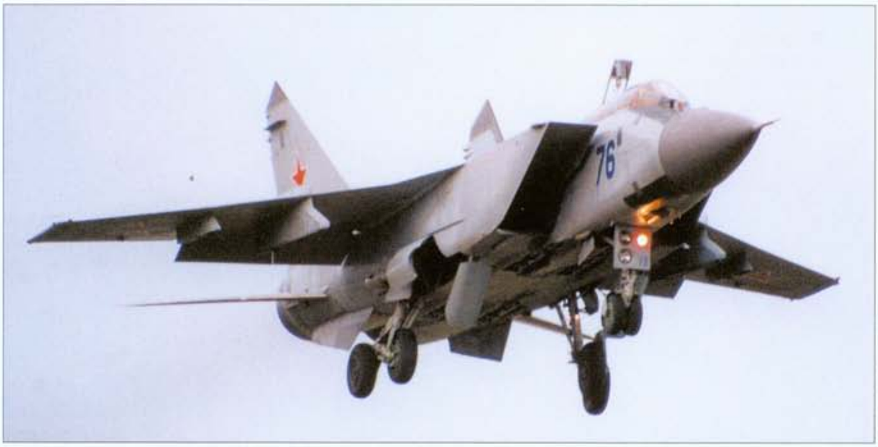
MiG-31B '76 Blue' on final approach. Curiously, the taxi light is on but not the landing lights.



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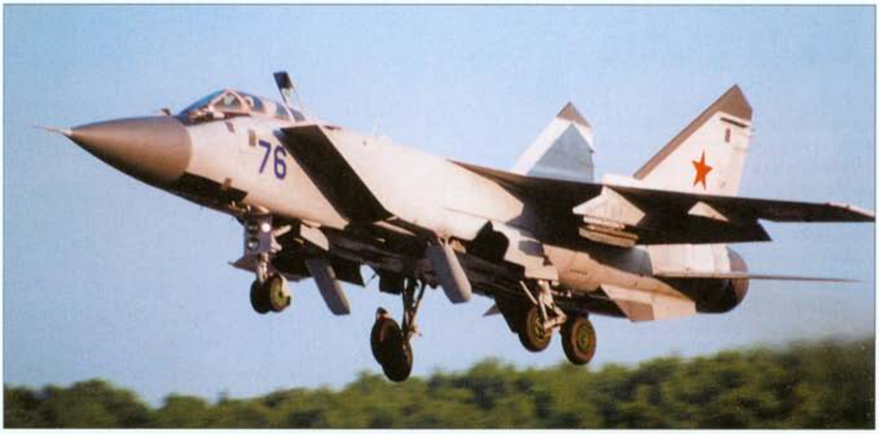
Another view of '76 Blue' a few seconds before touchdown. The periscope is of necessity mounted on tall struts to give an adequate view over the nose in this nose-up attitude.



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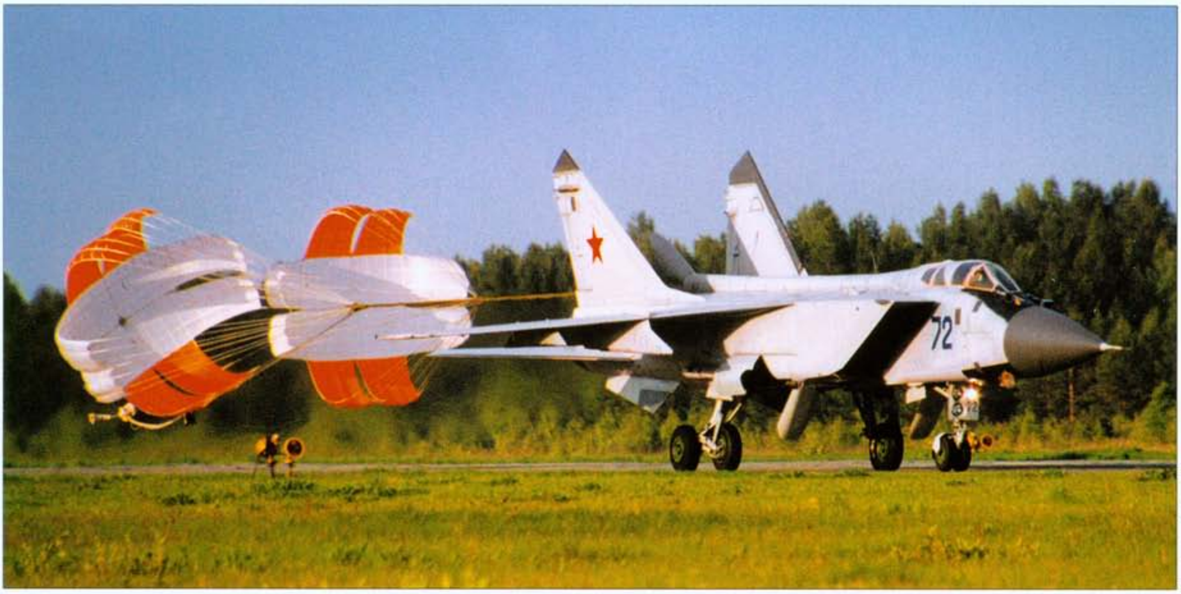
A magnificent shot of MiG-31B '72 Blue' as it completes the landing run, its twin cruciform brake parachutes deployed. Soviet (Russian) brake parachutes are typically orange and white.



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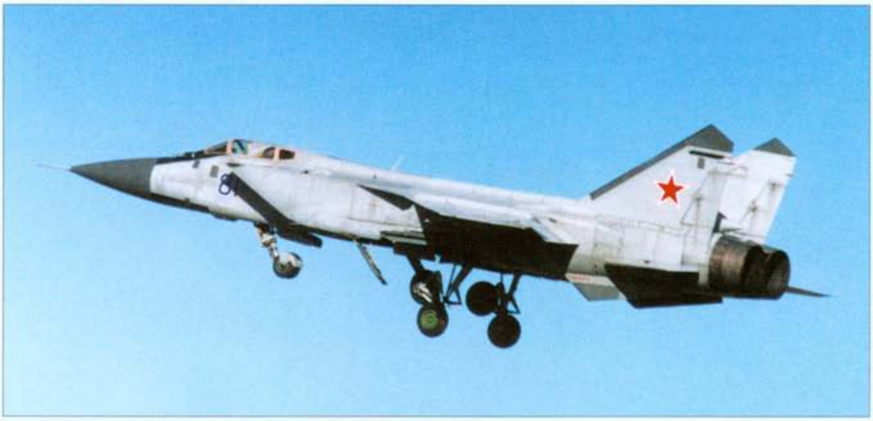
► '81 Blue' was one of the last MiG-31Bs to be delivered to Savasleyka AB. It is seen here 'cleaning up' as it takes off on another mission.



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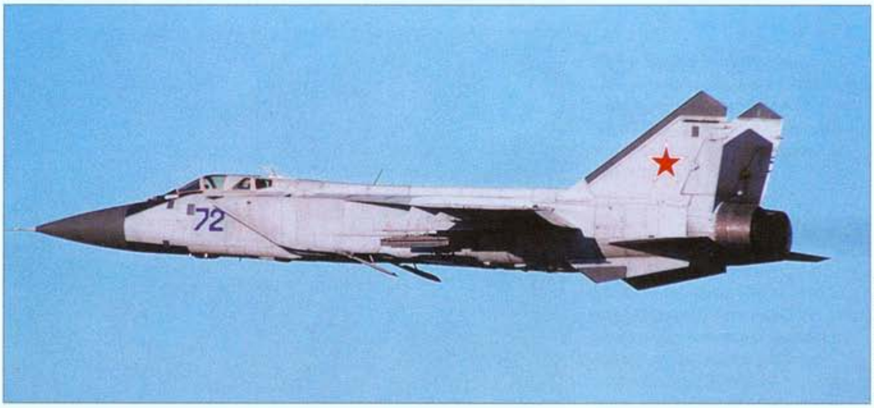
► A nice afternoon shot of '72 Blue' as it opens its airbrakes to keep formation with the camera ship.



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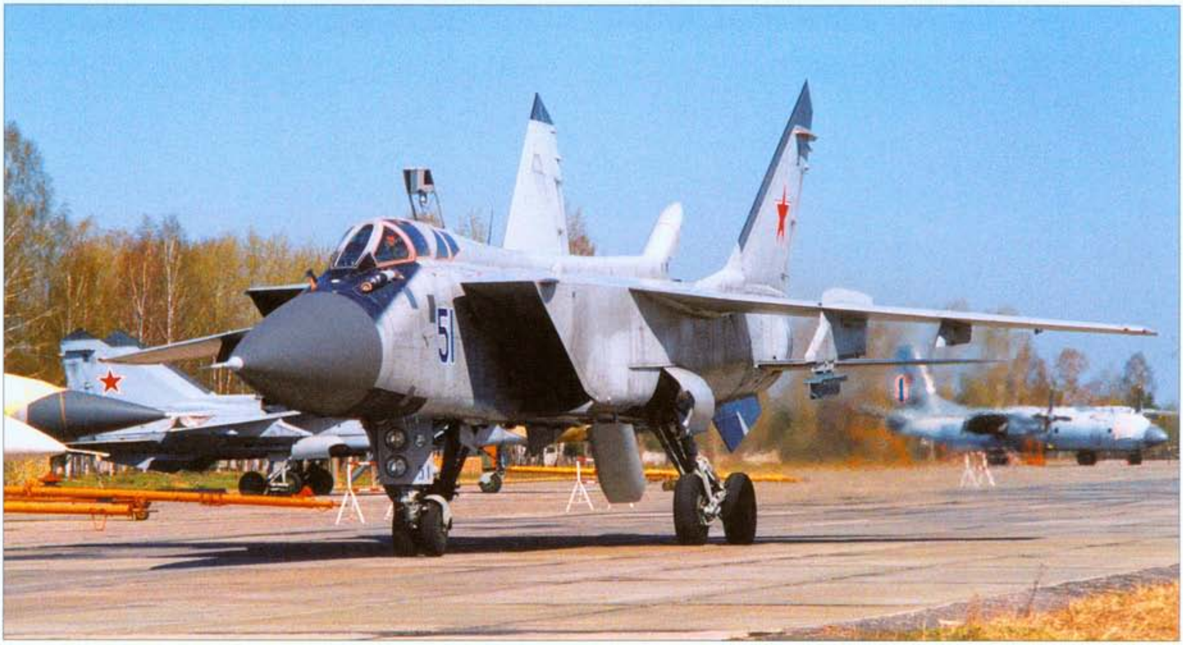
The day's mission accomplished, MiG-31B '51 Blue' taxies in past two sister ships, a Su-30 and an Antonov An-26 transport. Note the open brake parachute housing. ▼



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On 6th September of the same year, when a MiG-31 was firing AAMs, the aircraft performed an uncommanded sharp roll and flicked into a spin due to the failure of a missile to leave the port wing pylon. Attempts to recover from the spin proved futile, but the crew survived.

In the summer of 1996, when practising a landing after a simulated engine failure, yet another MiG-31 collided with an obstacle during an attempt to execute a go-around. The crew ejected, but one of the crew members was killed.

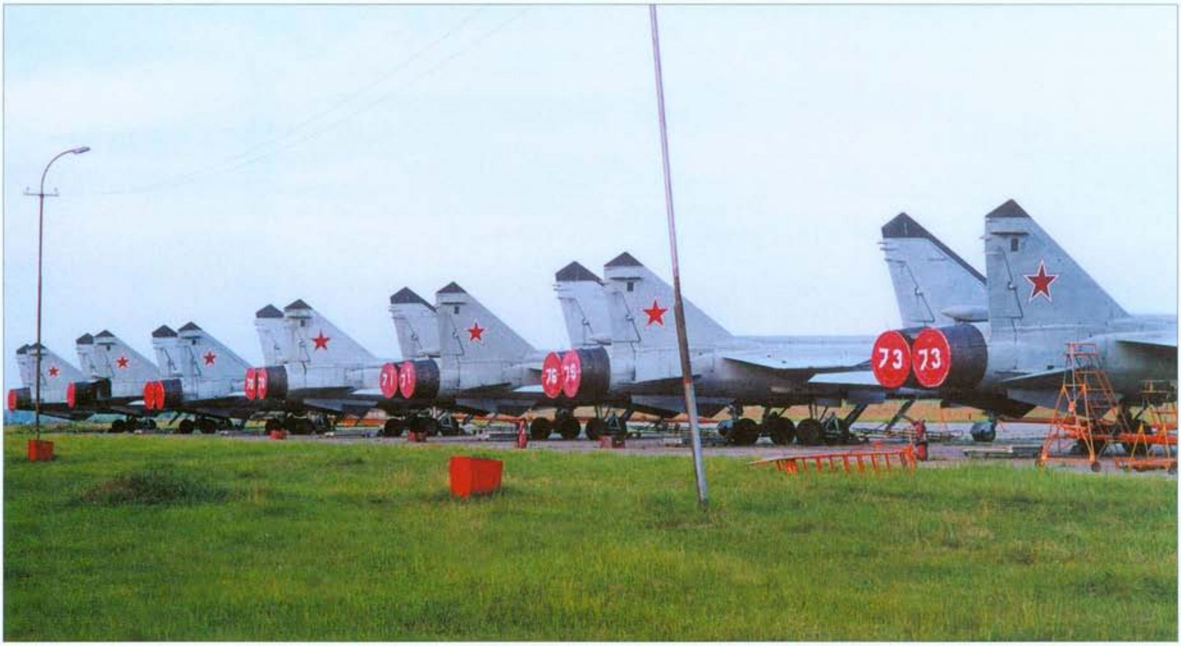
On 15th January 1997 an aircraft belonging to the 51st IAP crashed in the vicinity of the town of Oktyabrskiy, Arkhangel'sk Region. Both crew were killed. The crew (Major Vasiliy Strizhel'nikov and Captain Yuriy Shcherbanyov) stayed with the aircraft to the end; after a lengthy search the remains of the bodies were found at the crash site 12 km (7.45 miles) from the Kuloi railway junction. On the day of its crash the MiG-31 took off from an airbase in the town of Savvatiya (near Kotlas) for a routine training flight. Approximately at 1130 hours Moscow time the interceptor crashed into the ground from the altitude of more than 11,000 m (36,090 ft). Eyewitnesses said that the fighter had disintegrated while still airborne. The impact created a crater more than 15 m (50 ft) in diameter and 6 m (20 ft) deep. The search-and-rescue effort was started virtually immediately, and the flight data recorder was recovered.

One more MiG-31 interceptor crashed in the Tver' Region, near the town of Borisovskiy, on 26th September of the same year. The aircraft had taken-off from Khotilovo AB for a training flight; at 1911 hours Moscow time a fire broke out in the starboard engine. All attempts to extinguish the fire proved unsuccessful. Six minutes later the crew ejected; 30 minutes later it was picked up by the

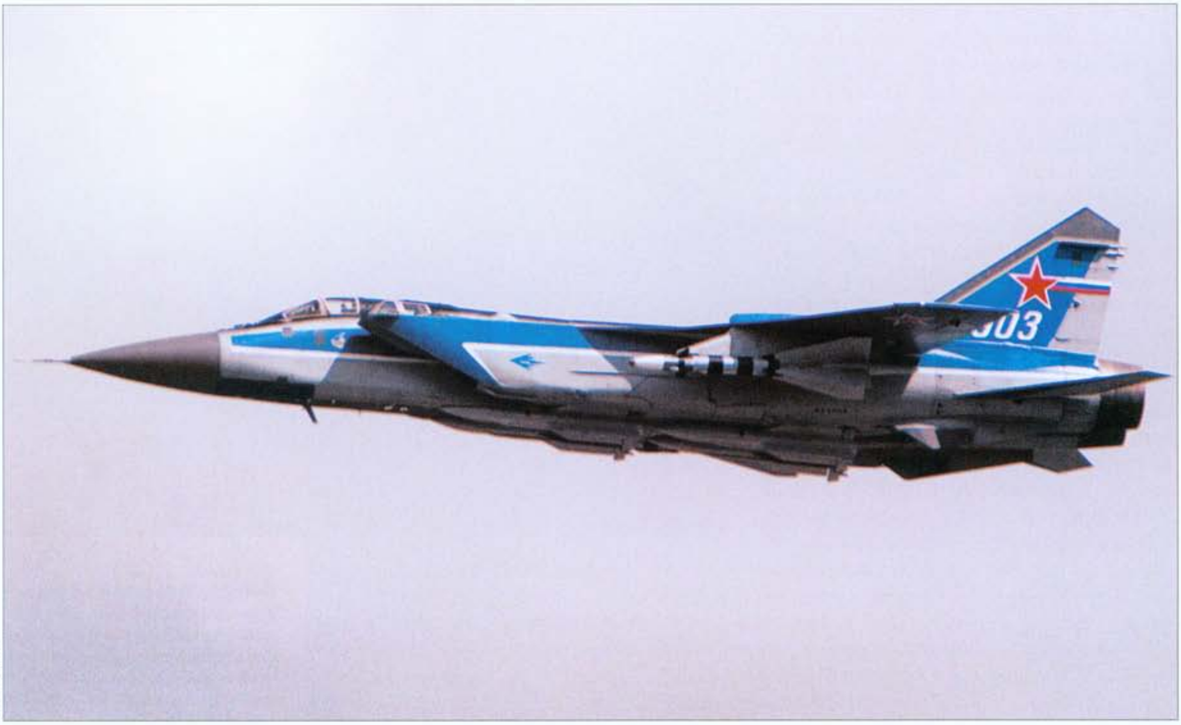
Yefim Gordon

▲
Five MiG-31Bs from Savasleyka make a formation pass over the public grandstand at Poklonnaya Gora in Moscow during the 1995 VE-Day celebrations.

The flight line at Savasleyka AB. Note how the interceptors' tactical codes are writ large on the nozzle covers for quick identification.
▼



Vyacheslav Martyniuk



Yefim Gordon

▲
Toting four dummy R-33s and two dummy R-40TDs, ANPK MiG's demonstrator aircraft ('903 White', c/n N38401208786) makes a demonstration flight. Note that '903 White' has a much thinner Russian flag augmenting the Russian Air Force insignia as compared to the similarly painted '374 White'.

search-and-rescue service and hospitalised for examination. The burning aircraft fell in a wooded and swampy area in the vicinity of the base, causing no harm to anyone.

In all, 35 accidents and incidents took place in the course of the MiG-31's squadron service up to the year 2000; this includes 12 fatal crashes. According to the conclusions made by the investigating panels, 19 of them were due to crew error.

According to information from various publications (including the Internet and reference books published in Great Britain and the USA), by the late 1980s the MiG-31 equipped regiments based at nearly 20 airfields over the vast territory of the Soviet Union. At different times they saw service with units stationed in Pravdinsk (786th IAP, deliveries made in 1981-82; MiG-31Bs were based there later), Monchegorsk (174th GvIAP, deliveries made in 1982-83), Komsomol'skoye AB (near the township of Sovetskiy, Tyumen' Region, deliveries made in 1984), at Arkhangel'sk-Talagi airport (518th IAP, deliveries made in 1985), at an unnamed airfield on the Kamchatka Peninsula (777th IAP, deliveries made in 1987-88), at Petropavlovsk-Kamchatskiy (Yelizovo airport, deliveries made in 1986-87), at Chugooyevka AB (deliveries made in 1989-90), at Omsk-Severnyy airport (64th IAP, seven machines delivered in 1987, a further 12 before 1990 and two MiG-31s (*izdeliye* 01DZ), in Bratsk (350th IAP, five machines delivered in 1988 and a further 12 before the end of 1989; later transferred to Perm'), in Rostov-on-Don (83rd IAP, deliveries made in 1993), at Khotilovo AB (790th IAP, deliveries made in 1993-1994), at Perm'-Bol'shoye Savino airport (764th IAP, MiG-31Bs/BSs delivered in 1993-1994), in Kansk-Yoozhnyy (MiG-31Bs delivered in 1993), at Noril'sk-Alykel' airport (delivered in 1991, possibly transferred to Kansk later), in Morshansk (the 153 rd IAP, the MiG-31s (*izdeliye* 01DZ) delivered in 1990), in Amderma (72nd GvIAP, deliveries made in 1987, possibly transferred to Kotlas).

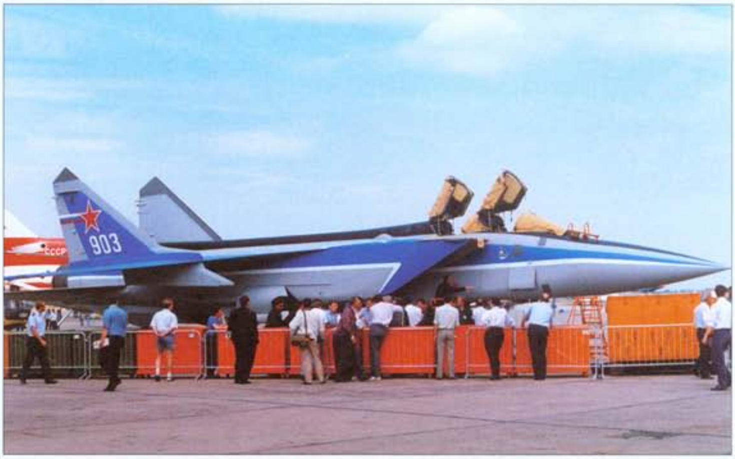
During the Soviet period the MiG-31s were also based in Kazakhstan, including the airfields in Sary-Shagan (12 MiG-31Bs were delivered in 1991) and in Semipalatinsk-1 (356th IAP, Zhana-Semey airfield, the first batch delivered in 1986, then the MiG-31Bs were transferred to this airfield from Sary-Shagan).

The majority of modifications and all repair work on the interceptor were carried out at the aircraft repair factory in Rzhev.

The MiG-31's first official appearance outside the Soviet Union took place in the shape of a model which was demonstrated in the Soviet pavilion of a trade fair in Manila in November 1990. There were plans to show the real interceptor at the IDEX military hardware exhibition in Dubai in January 1991, but the Gulf War caused the exhibition to be postponed to October; for this reason the international debut of the aircraft took place at the 39th Paris Air Show in June of the same year. Sporting a special display colour scheme with blue trim and the tactical code '374 White' (c/n N69700121496), the *Foxhound* touched down at Le Bourget airport on 10th June with Mikoyan ANPK (OKB) chief test pilot Valery Menitskiy at the controls; the second crew member was navigator Yuriy Yermakov. The interceptor took part in demonstration flights during the last days of the show, making low-level passes over the airfield and performing several aerobatic figures.

The MiG-31 did not miss the air show in Dubai in October; on their way back from this air show a group of Soviet aircraft, including the MiG-31, 'dropped in' at Teheran to demonstrate the hardware to the Iranians. In 1992 the interceptor was demonstrated in Britain at the Farnborough International '92 airshow. The MiG-31 repeatedly took part in various other international air shows, including those held in Canada, the United Arab Emirates (IDEX) and Germany (ILA). The interceptor was acknowledged as the most advanced aircraft of its kind in the world – at present, no other country possesses an aircraft that can match the MiG-31 in terms of take-off weight, armament and maximum speed.

Demonstration of the heavy interceptor in flight did not provoke any rapturous comments, but specialists estimated it at its true worth, noting especially its by-pass engines,



RART

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'903 White' poses at one of the Western airshows in company with the Yak-42F research aircraft (CCCP-42644). Note the canvas covers over the canopies.

'903 White' pictured at the moment of rotation at Zhukovskiy as it takes off from runway 12.
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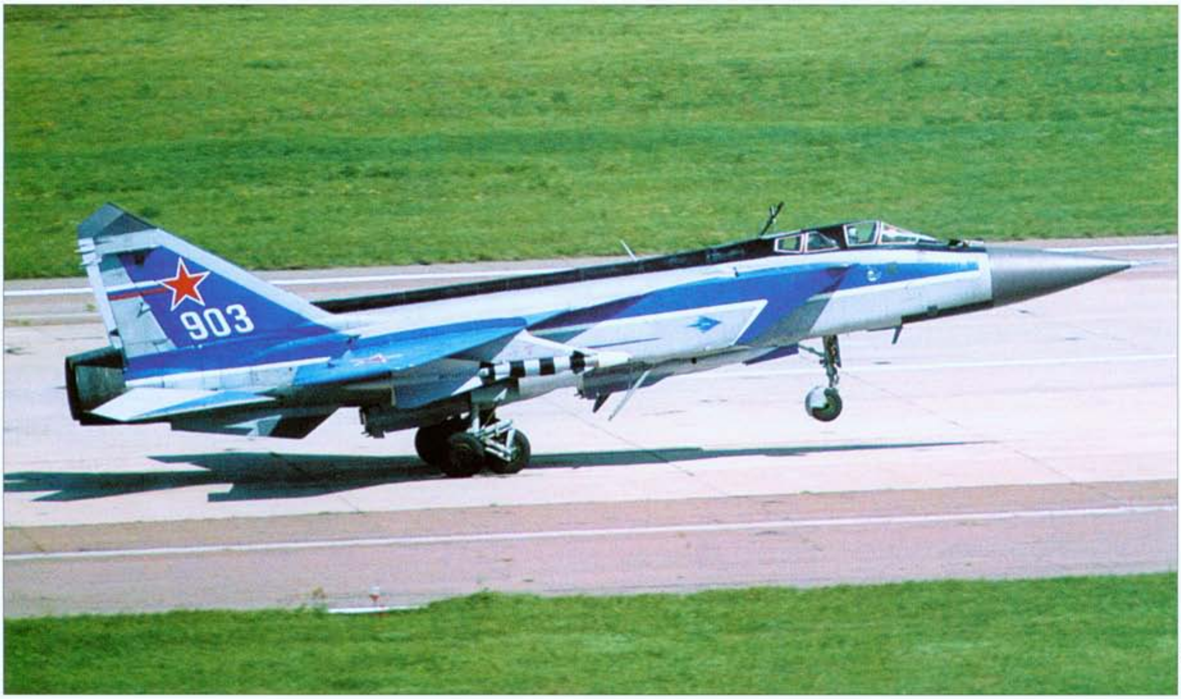
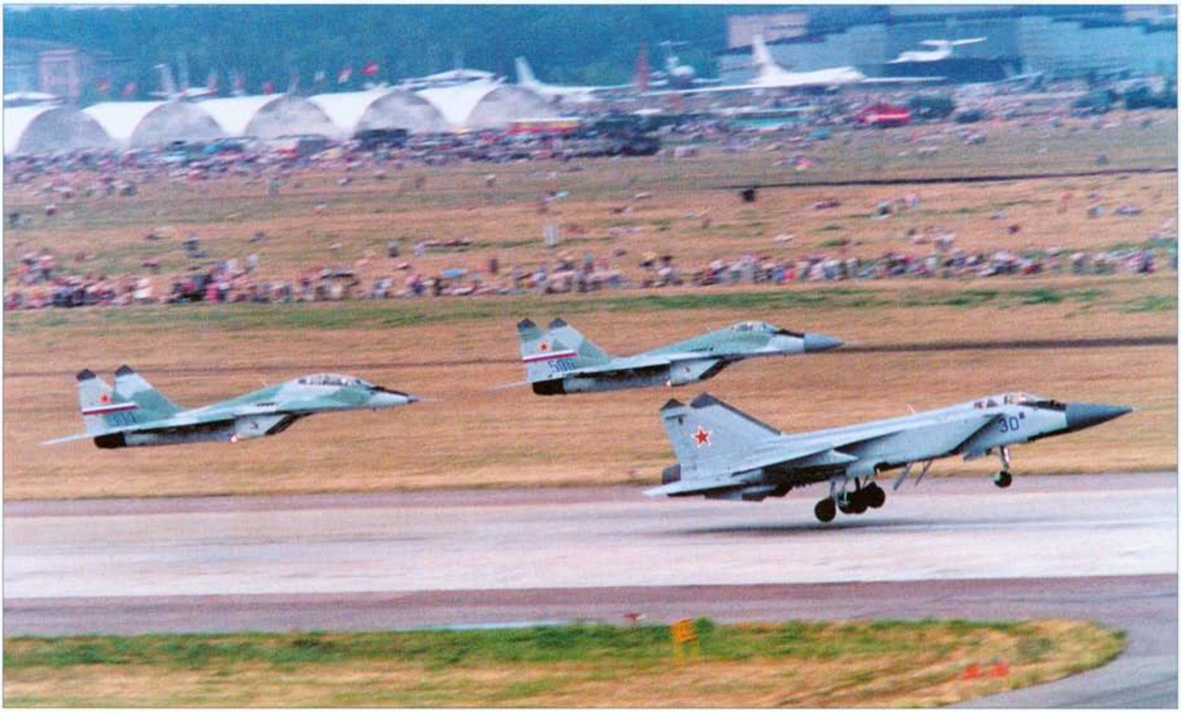
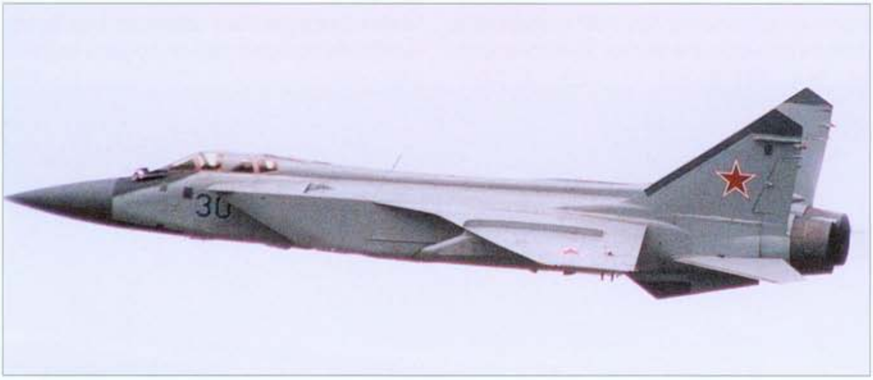


Yefim Gordon



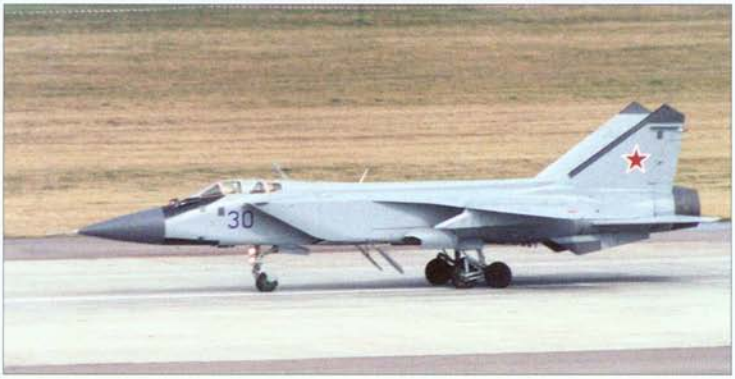
Yefim Gordon

▲
MiG-31B '30 Blue' makes a spectacular (and ear-splitting) formation take-off from Zhukovskiy's runway 12 with two of its stablemates belonging to RSK MiG, single-seat MiG-29 *Fulcrum-C* '506 Blue' and two-seat MiG-29UB '304 Blue', during one of the Moscow airshows. Note that the lighter MiG-29s have required less runway length to become airborne and are 'cleaning up' already.



Yefim Gordon

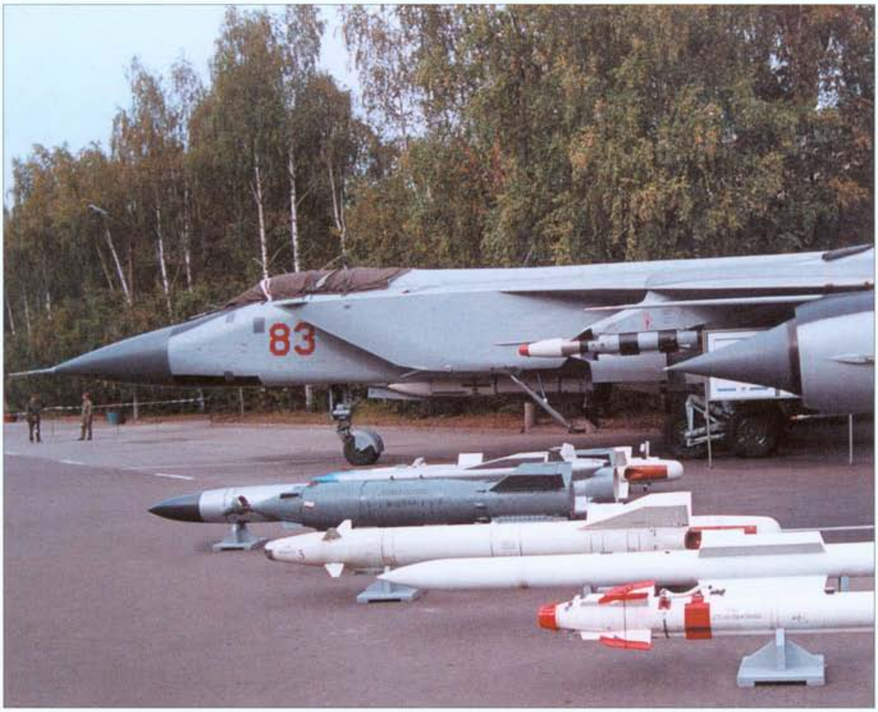
▲
MiG-31B '903 White' makes a high-speed dash during the demonstration flight.



Yefim Gordon

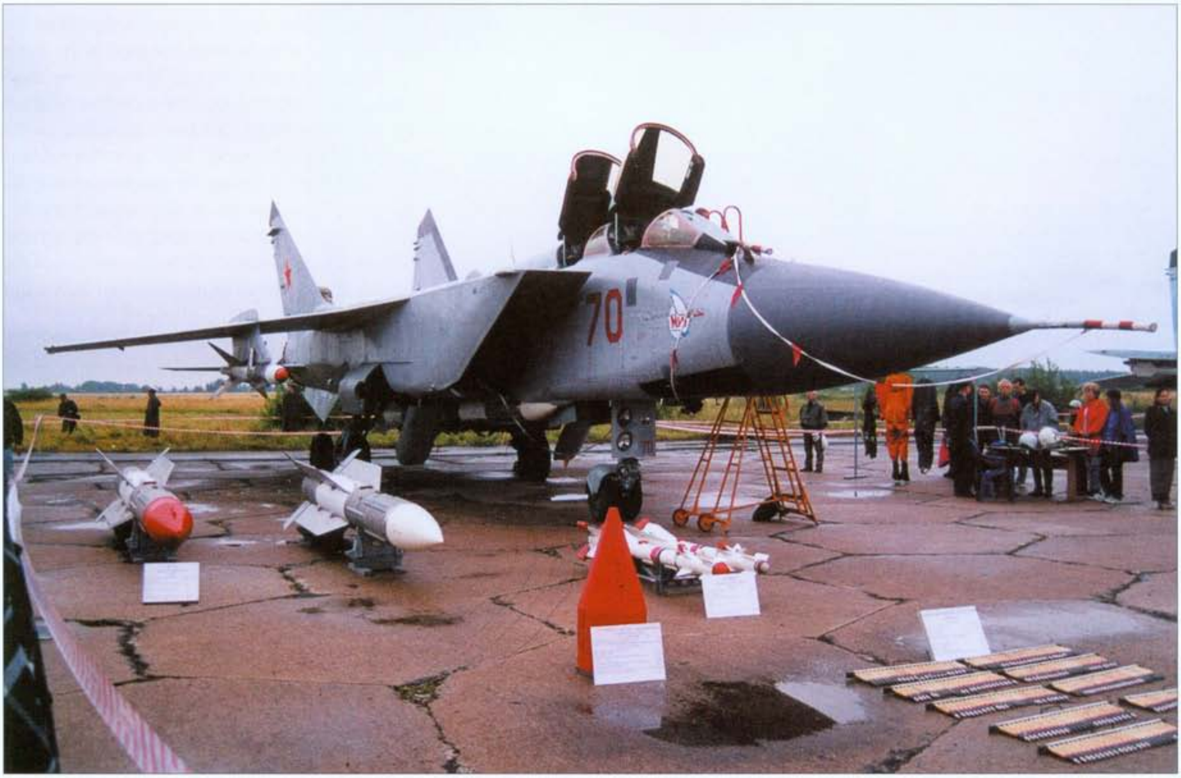
◄
The same aircraft lands on Zhukovskiy's runway 30 after completing the display routine.

▶
Russian Air Force MiG-31 *sans suffixe* '83 Red' is seen at Nizhniy Novgorod during a defence industry trade fair. Note the striped dummy R-40TD missiles under the wings. The impressive air-to-air and air-to-surface weapons array in the foreground applies to the MiG-21-93 on the right, not to the MiG-31.



Viktor Drushlyakov

'70 Red', another Russian Air Force MiG-31 *sans suffixe*, is shown here in the static park of the Business Aviation-2001 airshow at Pushkin near St. Petersburg on 5th August 2001. Despite the MiG OKB badge, this is not a company-owned 'dogship' but a regular in-service machine.
▼



Dmitriy Komissarov

T. Shia

▲ This MiG-31B was part of a large display of Russian Air Force hardware which also included a Su-27, a MiG-29 of the Strizhi aerobatic team and an An-124 Ruslan heavy transport. Note the advertising sticker of the Novolipetsk Iron & Steel Works (NLMK) which sponsored the show.

weapon control system and the armament: the six-barrelled cannon and the R-33 missiles. In Paris the interceptor was shown in the static park with the radome detached, exposing its main 'operational instrument' – the phased-array radar antenna. Indeed, the antenna attracted enormous interest. Even after having seen the antenna with their own eyes, some American engineers continued to allege that it was a usual slotted antenna with mechanical scanning. The most serious criticism voiced by Western specialists concerned the quality of the welding seams in the fighter's airframe structure, the set of navigation lights etc. Yet, the most realistic appraisal of the aircraft was given in the special issue of the Airshow Daily which noted that, although bearing some superficial resemblance to its predecessor – the MiG-25, the MiG-31 was a completely different machine capable of destroying any hostile aircraft at any altitude, thanks to its all-aspect target detection systems. It was stated that the MiG-31 could not be compared directly to any other new-generation fighter – it was just a good 'warhorse'.

The Soviet delegation made no secret of the motives which prompted the sending of such a classified aircraft to Paris. Deputy Minister of Aircraft Industry V. Ivanov modestly noted: 'We hope that our display will help you to find the partnership you need with the USSR.'

Unfortunately, only one partner was found – it was China. At the end of May 1992 a Sino-Russian agreement was concluded providing for the equipment of the People's Liberation Army Air Force (PLAAF) with 24 MiG-31s in a version capable of in-flight refuelling. Deliveries of the first five interceptors were scheduled for June 1992. There were plans for subsequent assembly of these aircraft under licence at the Shenyang Aircraft Industry Company (SAIC). The first Chinese-built MiG-31 was scheduled for roll-out in late 1994. Plans called for the manufacture of four fighters per month up to the year of 2000. However, by the mid-1990s China revised its plans, opting for the acquisition and licence manufacture of another Russian fighter – the Su-27SK/Su-30. Its main advantages were seen in its being multifunctional and super-agile – qualities that would come to good use under all circumstances.

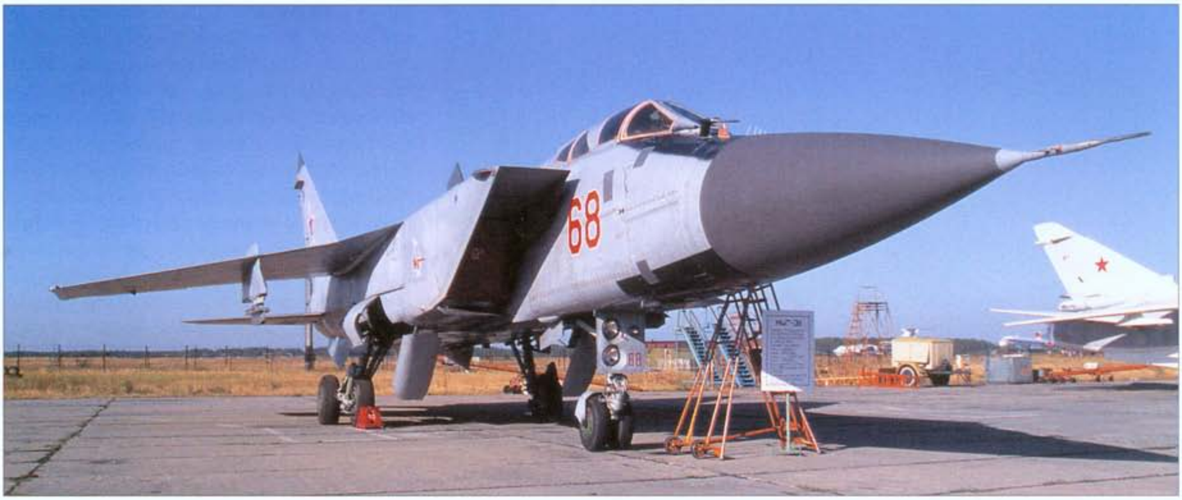
With regard to its combat capabilities the MiG-31 aircraft is, indeed, the best in the world in its class. It has taken part in numerous exercises and experiments, in the course of which unique information has been obtained on the possibilities of using the over-the-horizon (OTH) targeting radars for guidance over distances of thousands of kilometres from the target, on the interception of anti-shipping missiles flying at a height of a few metres over the sea surface, and of cruise missiles with a low radar signature, on the study of the influence of the underlying surface on the intercept precision, etc.

For example, the 174th IAP took part in the *Sever-87* (North-87) military exercise in the course of which four crews carried out their combat mission and then, as mentioned above, landed at an *ad hoc* ice airfield on Franz-Joseph Land. Four MiG-31s visited this airfield again during the *Otrazheniye-88* (Rebuff-88) exercise. In addition, in 1986-88 crews from the Monchegorsk-based regiment flew escort missions with Tupolev Tu-95MS-6 *Bear-H* strategic missile strike aircraft.

One more tactical flying exercise incorporating research purposes and dubbed *Voskhod-93* (Sunrise-93) was conducted by the Russian Air Force between 17th and 21st

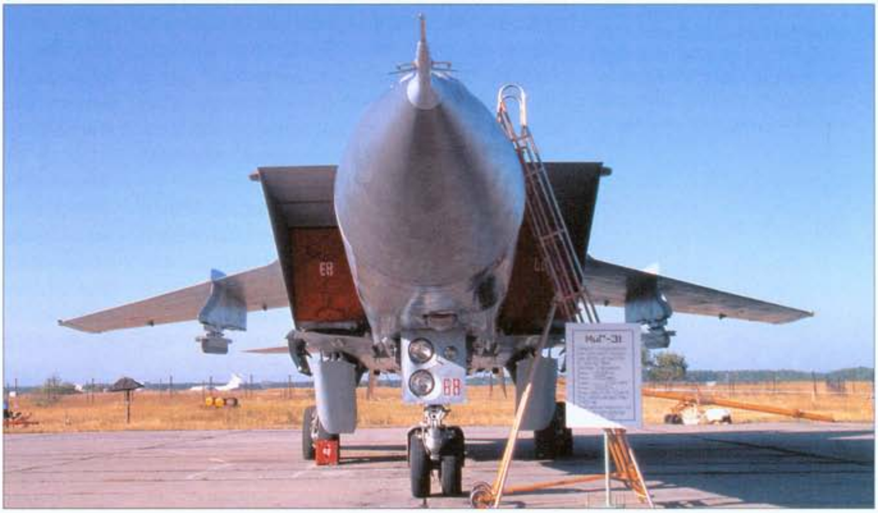
MiG-31B '77 Blue' was in the static park during an 'open house' at Savasleyka AB on occasion of Aviation Day celebrated on the third Sunday of August. ▼

Vyacheslav Martyniuk

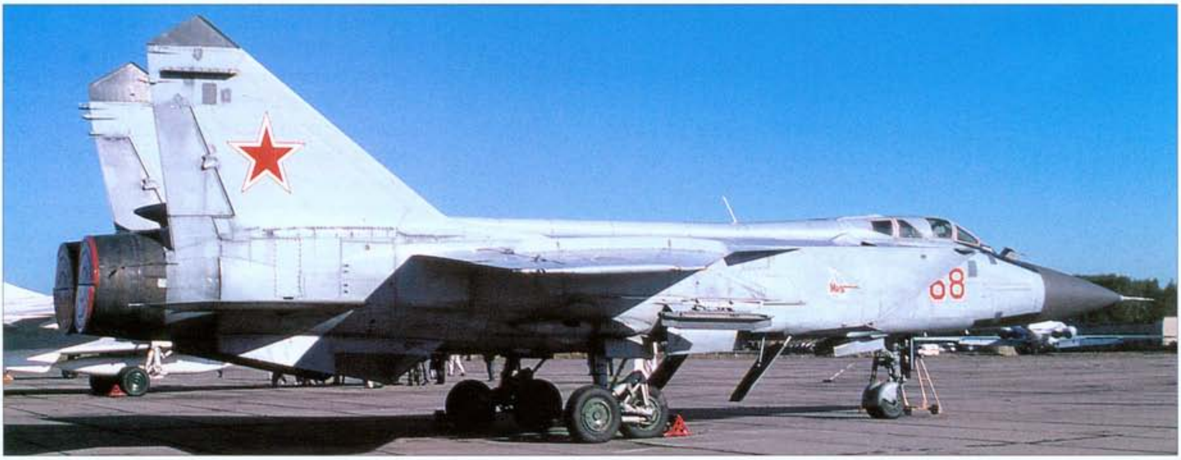


Yefim Gordon

▲ ►
Probeless MiG-31 '68 Red' (c/n N38400190127) was displayed statically at Chkalovskaya AB during the Aviation Day 'open house' on 18th August 2002.
▼



Yefim Gordon



Yefim Gordon

Ernest Katayev

▲ **Appropriately coded '31 Blue', this early-production probeless MiG-31 is preserved at its birthplace, the Sokol aircraft factory at Nizhniy Novgorod-Sormovo.**

May 1993; it featured a redeployment of ten Sukhoi Su-24M *Fencer-D* tactical bombers and Su-24MR *Fencer-E* tactical reconnaissance aircraft, four Su-27 fighters, six Tu-95MS-6 strategic bombers and eight MiG-31B interceptors from the European part of Russia to the Far East with four air-to-air refuellings from 13 Ilyushin IL-78/IL-78M *Midas-A/B* tankers en route.

From the second half of December 1994 a complement of MiG-31 and Su-27 interceptors ranging from two to six aircraft, together with an Ilyushin/Beriyev A-50 *Mainstay-A* AWACS aircraft, carried out combat patrol missions over Chechnya for some time during the First Chechen War.

At present the MiG-31 is the world's only aircraft capable of effectively combating the General Dynamics AGM-109 Tomahawk or Boeing AGM-86 ALCM air-launched cruise missiles. The following information was published in the Russian press. A check-up was conducted at the Sary-Shagan test range (in the vicinity of Lake Balkhash): the site simulating a target was known, but the time of arrival of a cruise missile to the target and the direction from which it would come were unknown. To protect the site, four Su-27P fighters were loitering at the baseline altitude of 5,000 m (16,400 ft); a similar mission was also performed by four MiG-31s, of which three machines provided full 360° coverage with overlapping and one machine co-ordinated the actions of the group. The crew of one of the MiG-31s noticed an incoming Tu-16, the cruise-missile carrier, already some 200 km (124 miles) away. The MiG's WSO could clearly see on his display that a second 'blip' detached itself from the 'blip' of the carrier aircraft; it 'vanished' instantly due to the difference in the radar signature of the carrier and the missile. However, the approximate direction was already revealed, and some time later, at a distance of 70 km (43 miles), the cruise missile flying at an altitude of about 50 m (160 ft) was detected and destroyed.

Another early-production MiG-31 preserved for posterity – and again not readily accessible. '32 Blue' is an exhibit of the base museum at Savasleyka. ▼

Yefim Gordon

A similar result was achieved by pilots of the 174th IAP over the Barents Sea when a MiG-31, forestalling the competing Su-27P, was the first to detect and destroy an R-6 anti-shipping missile that had been launched from a submarine and was flying close to the water surface.

These experiments received an additional impetus after the radical reduction of the unified Air Force (incorporating the previously separate Air Defence Force) which resulted in a part of the country's territory being stripped of its fighter and SAM cover. Experiments with long-range flights were resumed in the Air Force. On 1st July 1998 pilots of the former PVO's 148th Red Banner Combat Training and Aircrew Conversion Centre at Savasleyka AB carried out a non-stop flight of unprecedented complexity for research purposes, covering a distance of 8,500 km (5,283 miles) in ten hours. The flight was routed over the European part of Russia. In the course of the flight, fulfilment of combat tasks was practised successively near the southern, northern and western borders of the country. Apart from coping with the technical complexity of a long-duration flight, the exercise was intended to fulfil some other tasks. A victory in modern warfare, especially with the modest and even dwindling forces available, can only be based on the interaction of various means complementing each other. It was precisely the joint group actions that were practised in the course of carrying out the tactical mission envisioned by the research flight.

It was the northern section of the route that posed special difficulties in this respect. To intercept the designated adversary simulated by one of the pairs a mixed group was formed, comprising nine aircraft: an A-50 AWACS aircraft, two MiG-31B interceptors from the 786th IAP, four Su-30 interceptors from the 148th TsBP i PLS and two IL-78 tankers. The A-50 was flying a patrol mission in a designated area; it monitored the air situation in a large area and brought all the aircraft into a single group. The MiG-31s, which had taken off from the airfield in Pravdinsk, were flying in the forward echelon; making use of their unique radar, they located the targets at a distance of up to 200 km (124 miles) and relayed the information to the Su-30 pilots from Savasleyka. The fast and agile Su-30s flying some 60 km (37 miles) behind the MiGs were ready to engage their afterburners and attack the adversary, although the MiGs themselves could destroy many targets simultaneously with their R-33 missiles.

The simulated interception was successfully carried out at the latitude of Arkhangel'sk. At the moment of interception the aircraft which posed as the 'adversary' were flying on a course corresponding to the direction from which bombers and cruise missiles might be attacking Moscow from the north. The tactics thus tested can be used at any time over the entire territory of Russia and the adjoining waters.

Organisation and conduct of the flight was carried out under the guidance of former Chief of the Fighter Aviation of the Air Force Major-General Victor Aksyonov and former 148th TsBP i PLS Chief, Colonel Stanislav Kishenkov. The unique character of the research mission consisted in the fact that for the first time standard service fighter units of the Air Force had carried out a flight of ten hours' duration (!) and practised combat training tasks in the skies of three (!) regions of a vast country.

For the sake of justice one must note that during the initial stages of introduction of the MiG-31 into service the unique capabilities of this fighter could far from always be put to good use. That was the case, for example, when the reason for the rather unsuccessful actions of the MiG-23 fighter in the course of the Syrian Air Force's combat operations over Lebanon in 1982 was investigated. The hasty service introduction of the MiG-23ML *Flogger-G* – a lightweight version of the MiG-23 – did not make it possible to thoroughly study its combat capabilities; therefore, these studies were continued as a matter of extreme urgency under the guidance of Air Marshal A. N. Yefimov, using a fighter regiment based at Vaziani (Transcaucasian Military District). Involved in this work were also the pilots of the Tactical Aviation's 4th TsBP i PLS in Lipetsk, as well as the designers of the *Sapfeer-23* (Sapphire-23) fire control radar.

Yefim Gordon

▲
'96 Blue' (c/n N69700106125), the MiG-31 that used to be a teaching aid in the Solntsevo tech school, is now on display at the Central Russian Air Force Museum in Monino. Curiously, the pylons are displayed separately from the aircraft.

The main purpose of the research consisted in studying the capabilities of the radar during intercepts conducted over mountainous areas. In the course of the work the flights were transferred to Nasosnaya AB (not far from Omsk) where the 64th IAP was based. In the course of several flight days studies were made of the possibility of guiding the MiG-23ML fighters to their targets by means of commands sent from a MiG-31 which was used as an AWACS aircraft. For this purpose four MiG-31s which were passing service tests at that time temporarily deployed to Nasosnaya. The results of interaction of the two fighter types proved clearly unsatisfactory (later the 64th IAP re-equipped with MiG-31s, but in the spring of 1988, following the restructuring of the Russian Air Force and the Air Defence Force, the regiment was disbanded).

Once again, successful 'combat experience' with the MiG-31 was obtained in the period between 31st August and 4th September 1998 over the Ashuluk test range (near Astrakhan'). This place was chosen for joint exercises with the participation of air defence units from Belorussia, Kyrghyzstan, Kazakhstan and Russia. Interestingly, the Air

Defence Forces of Kazakhstan were represented there by three MiG-31 interceptors. Indeed, in addition to the Russian Air Force, the MiG-31 serves with the Air Force of Kazakhstan. As far back as 1988 the 356th IAP based at Zhana-Semey airfield near Semipalatinsk converted to the new interceptors, and after the break-up of the USSR the Semipalatinsk-based MiGs were included in the complement of the Kazakhstan Air Force.

Some other important tasks as well were practised during exercises held in the Far East in mid-September 1999. The MiG-31B interceptors using long-range AAMs shot down under adverse weather conditions a *Malakhit* (Malachite) target missile launched from the Moroz small missile boat. The main purpose of the exercise consisted in practising the interaction of the Air Force fighter aviation and the Naval forces. The 1999 exercises, unprecedented in their scale for the Russian Armed Forces, became a direct response to NATO aggression in Yugoslavia.

In the course of another episode a pair of Tu-22MR *Backfire-C* reconnaissance aircraft taking off from Vozdvizhenka AB and escorted by the MiG-31s performed a flight within the inner perimeter of the Sea of Japan at a distance of 100 km (62 miles) from the limits of the international waters. This flight stirred much interest on the part of the Japanese military. The reconnaissance aircraft succeeded in spotting an additional 12 radar sites that had not been put into action when this area was overflown previously by single aircraft.

'Shine your light on me.' Seriously, this fantastic dusk shot of '70 Blue' shows that the *Foxhounds* and their crews are ready for action around the clock and in any season. ▼

Vyacheslav Martyniuk

At present the Fighter Aviation of the Air Defence Forces of Russia is equipped mainly with the interceptors featuring a modernised armament system (MiG-31B and MiG-31BS). A considerable part of the earlier-production machines (MiG-31s *sans suffixe*) have been consigned to storage at Lipetsk. Also the manufacturer – the Sokol aircraft plant in Nizhny Novgorod – has agreed to receive the aircraft that have to be kept in storage after being withdrawn from use. This is a logical step from the plant, which bears in mind an eventual modernisation of the interceptors for the Russian Air Force.

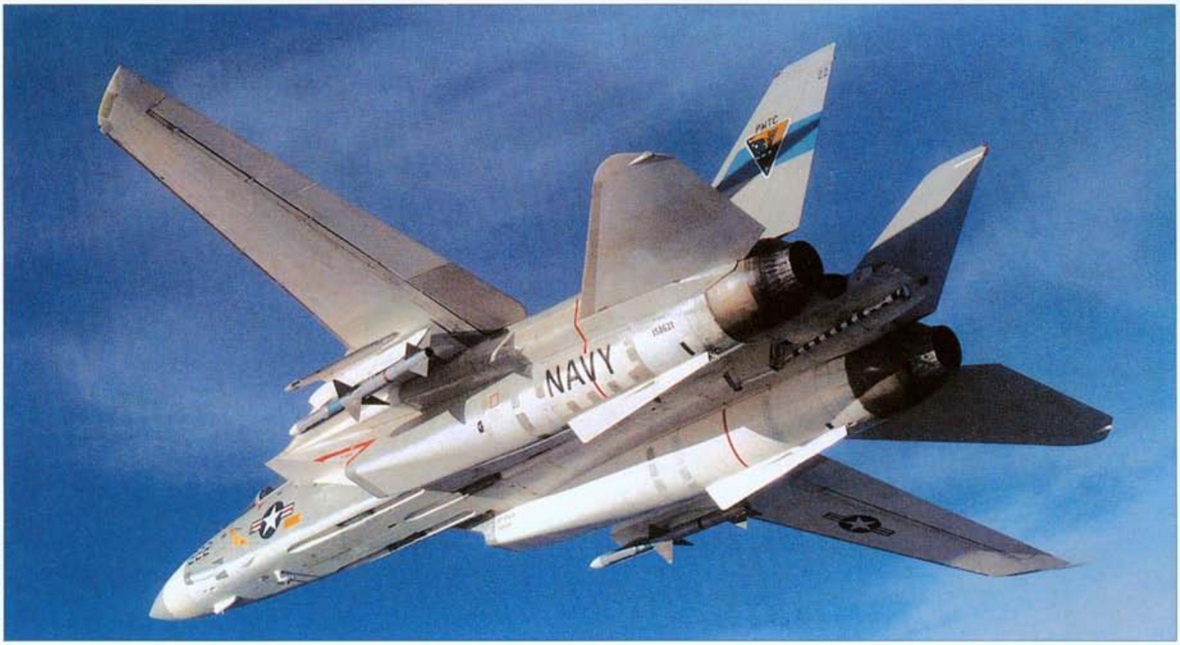
Pilot training is conducted, as before, at Savasleyka AB, albeit the air unit which is based there no longer carries the proud and renowned name of the 148th TsBP i PLS. In connection with merging of the Air Force and the Air Defence Forces the Centre was disbanded and its functions were transferred to the 4th TsBP i PLS of the former Tactical Aviation which is now called simply the 4th TsBP i PLS of the Air Force. The MiG-31Bs that were based at Savasleyka still remain there, but one cannot rule out that one more round of some sort of restructuring (in fact, reduction) will seal their fate.

The MiG-31 has been put on show in several Russian aviation museums. For example, the Central Russian Air Force Museum in Monino south of Moscow boasts two examples – a development aircraft coded '202 Blue' (c/n N69700102176, f/n 0202) and a machine coded '96 Blue' (c/n N69700106125, f/n unknown), before being consigned to the Museum, had been used as an instructional airframe at the now disbanded PVO Junior Aviation Specialist School in Solntsevo (on the south-western outskirts of Moscow). Preserved on the territory of the Sokol plant in Nizhniy Novgorod is a MiG-31 with the symbolic tactical code '31 Blue'.

In 1999 a monument was inaugurated at the entrance to Arkhangel'sk-Talagi airport to honour the pilots flying in the northern latitudes; mounted on a high plinth is a MiG-31 interceptor which had served in the 518th Berlinskiy IAP; this unit was awarded the Suvorov Order.

PART FOUR

FOXHOUND
Versus
TOMCAT



PMTC/World Air Power Journal

▲
A production F-14A-65-GR (BuNo 158621) operated by the US Navy's Pacific Missile Test Center at NAS Point Mugu, California (note the PMTC badge on the tails) with the wings at minimum sweep and a pair of AIM-7 Sparrow radar homing missiles on the wing glove pylons. Note the recesses under the fuselage for more Sparrows, the centreline hardpoint and the shape of the convergent-divergent nozzles at full military power.

A total of 505 MiG-31 interceptors in various versions had been built in the USSR before production ended. About 300 of these aircraft are currently in service with the Russian Air Force, another 43 being in service with the Kazakh Air Force. By comparison, 557 F-14A Tomcats in the same class had been manufactured for the US Navy.

According to trustworthy Russian sources, the combat potential of the F-14A and its weapons system equals 60 to 70% of the MiG-31. As for the other production Western fighters (the Boeing (McDonnell Douglas) F-15, Lockheed Martin F-16, Boeing (McDonnell Douglas) F/A-18, Dassault Mirage 2000, Panavia Tornado F.3 etc.), in the opinion of Russian experts, comparing their capabilities with those of the MiG-31 in beyond visual range (BVR) missile combat is simply inappropriate.

The YF-14 prototype made its maiden flight on 21st December 1970; deliveries of initial production aircraft to the VF-1 and VF-2 fighter squadrons which were part of the nuclear-powered aircraft carrier USS *Enterprise's* carrier wing in October 1972. The world's aviation community was vastly impressed when the results of the Tomcat's weapons system trials were disclosed; in June 1973 the Tomcat managed to destroy an aerial target on a reciprocal heading at 203 km (126 miles) range! The dynamic characteristics of the production F-14A were initially considered to be adequate for such a relatively heavy aircraft. Moreover, at the US Navy's 'Top Gun' Fighter Weapons Training Center, Tomcat crews come out on top in mock combat with the lighter and far more agile Northrop T-38A Talon combat trainer, albeit they had to use special tactics to win.

Although the MiG-31 was not specifically designed in response to the Tomcat, its development began almost immediately after the F-14A's appearance in 1972. Later, however, the continuing growth of the potential adversary's offensive capability and the advent of long-range cruise missile forced the Soviet designers to stand up to the challenge from abroad – a situation they had found themselves in more than once. As was the case with the American interceptor, the latest Soviet interceptor's new avionics suite and new armament were its main 'selling points'.

In fact the MiG-31 was the world's first production combat aircraft to feature a phased-array radar. Its main weapons consisted of four R-33 long-range semi-active radar homing missiles. These were augmented by two R-40TD medium-range AAMs with semi-active IR homing, four R-60M short-range heat-seeking AAMs and a 23-mm GSh-6-23 internal cannon.

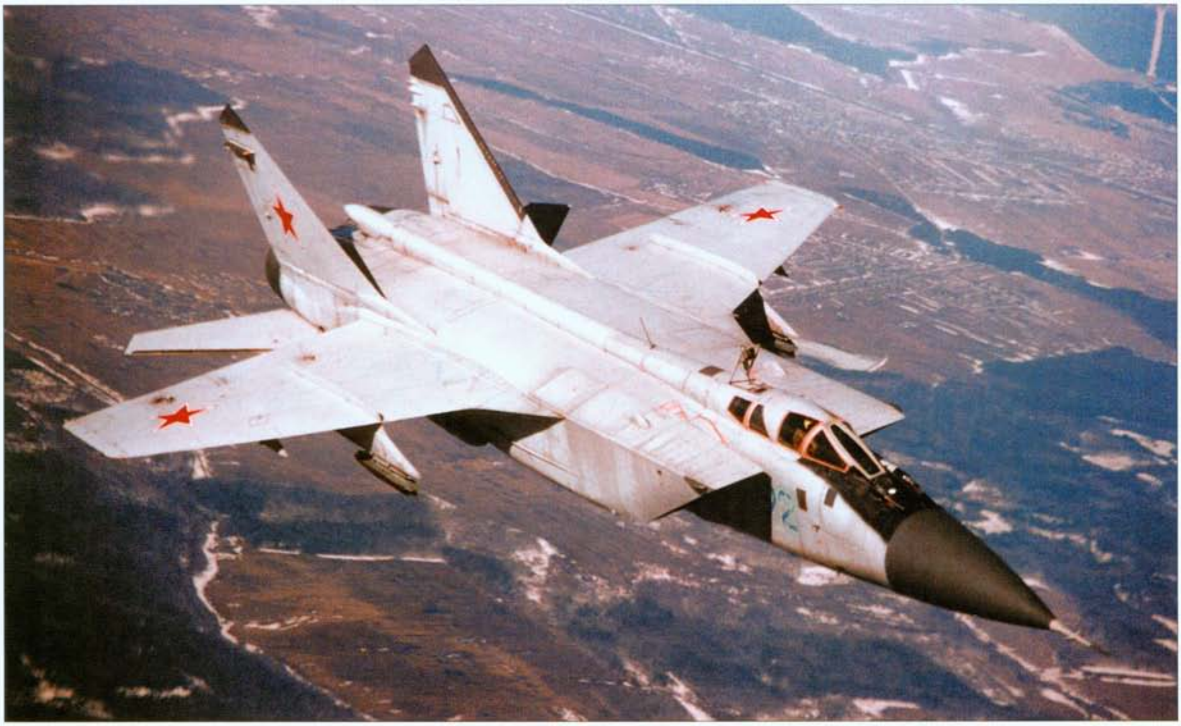
The virtually permanent presence of the potential adversary's offensive forces (strategic bombers, carrier groups and missile-armed nuclear submarines) along the northern and Far Eastern borders of the Soviet Union compelled the Soviet designers to create an aerial target interception complex that closely paralleled the MiG-25 in ideology but utilised much more advanced technologies.

Born when the Cold War was at its coldest, the MiG-31 and the F-14A remain uniquely capable aircraft to this day as far as their missions, functions and performance are convened; moreover, they were born of much the same concept. Both aircraft are two-seat long-range supersonic interceptors capable of lengthy patrolling and interception of aerial targets at extreme ranges. They are also the world's only fighters to be armed with long-range air-to-air missiles (the R-33 and the AIM-54 Phoenix). The aircraft are equipped with highly efficient avionics, first and foremost the weapons control systems (the 'Zaslon' and the AN/AWG-9 respectively). Both aircraft were in production for a long time and remain an important component of their respective nations' air defence forces into the 21st century.

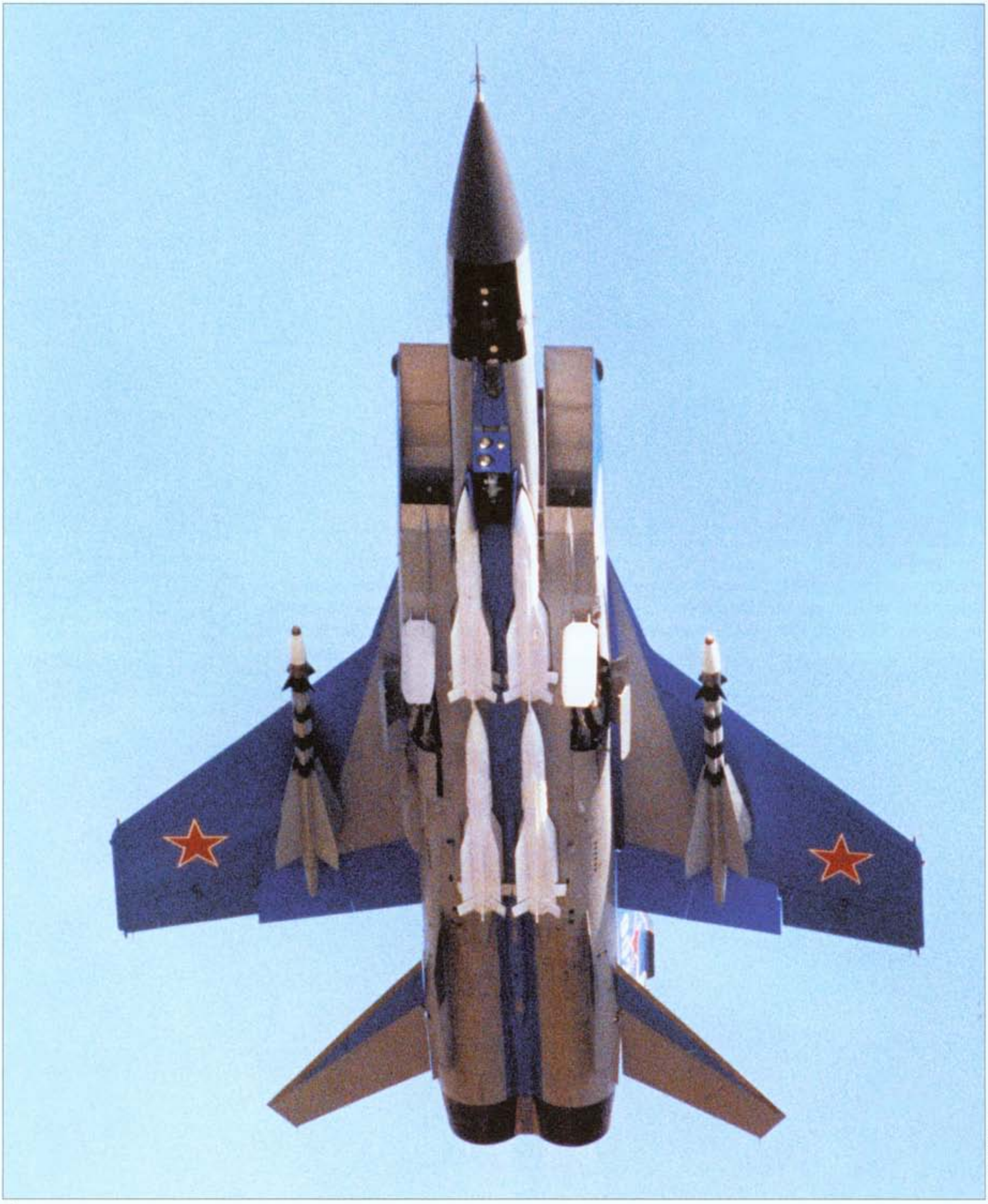
A comparative analysis of the performance parameters and manoeuvrability characteristics of the MiG-31 with four R-33 missiles and the F-14A with six AIM-54As was published in the Russian press by the nation's leading experts in aircraft systems design. The comparison showed that the MiG-31's service ceiling was 1,500-2,500 km (4,900-8,200 ft) higher than that of the F-14A. The MiG-31's maximum Mach number at altitudes above 13,000 m (42,650 ft) was 2.82 versus 2.35 for the F-14; at 17,000 m (55,770 ft) the Russian interceptor was 670 km/h (416 mph) faster than its US counterpart. On the other hand, at altitudes between 5,000 and 13,000 m (16,400-42,650 ft) the MiG-31 is slower than the F-14. Thus, the *Foxhound* is a high-altitude interceptor while the F-14 is optimised for destroying aerial targets at low and medium altitudes. In order to gain an advantage over the F-14 at these altitudes the Russian interceptor needs to fly 3,000-4,000 m (9,840-13,120 ft) above the adversary; yet you have to give credit to the MiG-31: thanks to the D30F-6 turbofans it is much better off at low and medium altitudes than its forerunner, the MiG-25, whose R15B-300 turbojets were optimised for high supersonic speeds and stratospheric altitudes.

The MiG-31's main advantage over all other currently existing interceptors is its ability to cruise at high Mach numbers for extended

'72 Blue', a production MiG-31B operated by what was then the PVO's 148th Combat & Conversion Training Centre at Savasleyka AB. Note the deployed forward view periscope in the rear cockpit.
▼

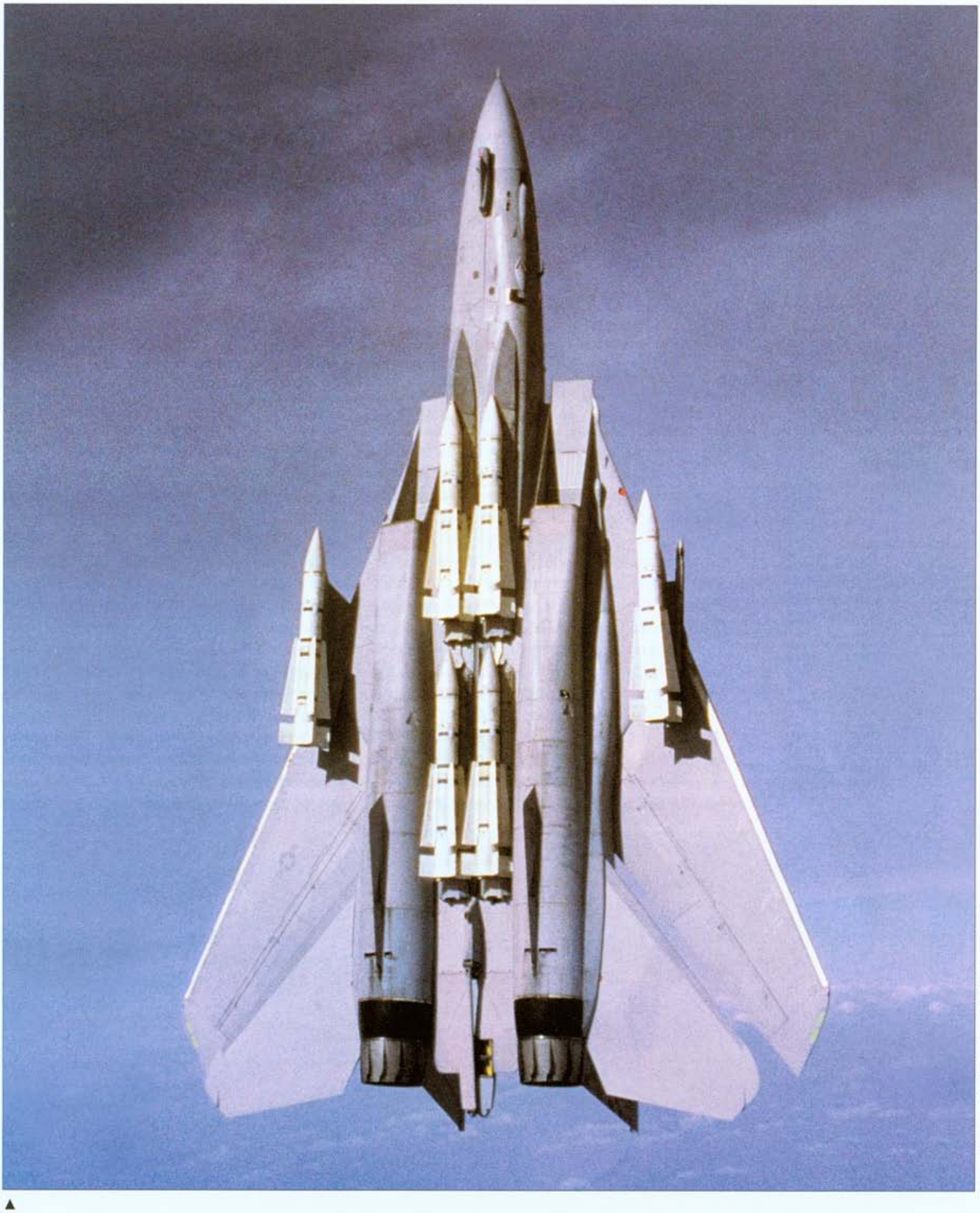


Vyacheslav martyniuk.



Victor Drushlyakov

▲
MiG-31 '903 White', a company demonstrator in the same colour scheme as '374 White', 'cleans up' after take-off with a full weapons load of four R-33s under the fuselage and two dummy R-40TDs on the wing pylons. The black IRST anti-glare panel under the nose is easily visible.



George Hall/Check Six Productions/World Air Power Journal

▲
A US Navy Tomcat shows off its power in a vertical climb with the wings at 68° maximum sweep and six Phoenix missiles on the pylons. The bulky AIM-54 requires special adapters to be fitted to the fuselage hardpoints.

Grumman/World Air Power Journal

▲ An Islamic Iranian Air Force F-14A-GR (6027) takes on fuel. The Tomcat's IFR probe is fully retractable.

periods. Thus, the combat radius at Mach 2.35 on internal fuel (without drop tanks) is 720 km (447 miles). The time to effect such a maximum-radius intercept mission and return to base is only 40 minutes – an unprecedented figure in modern fighter aviation.

A comparison of the MiG-31's and F-14's efficiency as weapons delivery platforms based on the time-to-range parameter showed that the MiG-31 was superior to all versions of the F-14. Given the same conditions (ambient temperature etc.), the Russian interceptor's maximum interception range is 2-2.5 times greater. Also, the MiG-31 attains a given interception range much quicker, the advantage growing rapidly as the range increases; this demonstrates the overwhelming advantage of the Soviet design whose airframe made of heat-resistant steels (50%), duralumin (33%) and titanium (17%) is wrapped around 16,300 kg (35,930 lb) of jet fuel with a high flash point. Consider that at ranges of 300, 500 and 700 km (186, 310 and 434 miles) the advantage over the F-14 is 1 minute 6 seconds, 3 minutes flat and 26 minutes 12 seconds respectively! Thus the reporting name *Foxhound* turned out to be an apt one – and a compliment (contrary to the intentions of those who gave it).

At the speeds and altitudes at which most present-day fighters typically operate, however, the high-speed, high-altitude operation is nothing out of the ordinary. The combat radius in subsonic mode (Mach 0.85) without drop tanks is 1,200 km (745 miles), increasing to 1,400 km (870 miles) with drop tanks.

MiG-31B '52 Blue' about to take on fuel from an IL-78. ▼

Vyacheslav Martyniuk

The F-14's range with drop tanks is 3,300 km (2,050 miles). The combat radius with six AIM-54 AAMs at optimum altitude is 1,200 km. If the mission is combat air patrol with one hour's on-station loiter time at maximum range from the carrier, the combat radius is reduced to just 660 km (410 miles). In this case, however, the aircraft's speed when attacking an incoming target is Mach 1.3.

Obviously the F-14 *per se* is much more fuel-efficient than the MiG-31. The ferry range of both aircraft is similar, being about 3,300 km, but the Russian fighter has a fuel burn of 5.56 compared to only 2.62 kg/km (9.3 lb/mile) for the US fighter – thanks mainly to the latter's more fuel-efficient engines.

In a nutshell, the design of the MiG-31 and the F-14 embodies fundamental differences resulting from the different tactics formulated as early as the two fighters' preliminary development stage. The Russian fighter is ideally suited for intercepting fast targets at long range in quick-reaction alert mode (or, in the case of the MiG-31B with in-flight refuelling capability, in patrol mode as well). The F-14, on the other hand, is designed for air defence in combat air patrol mode, patrolling the airspace at a considerable distance from the aircraft carrier; this makes it possible to keep a potent CAP with rapid reaction capability aloft for a fairly long time. On the other hand, if a carrier group is suddenly attacked by, say, a formation of Tu-22M3 *Backfire-C* strike aircraft carrying Kh-22 stand-off anti-shipping missiles, chances are that the F-14s standing on QRA duty on the carrier's deck will not be able to come within interception range in time to ward off the attack.

The American experts' confidence in the F-14A's adequate thrust and acceleration characteristics lasted until the autumn of 1983 – and was shaken when the first operational MiG-31s made their appearance in the Soviet Far East. Even though the *Foxhound* clearly was not designed as a dogfighter, during their frequent encounters with US Navy fighters during patrol missions the Soviet crews would sometimes demonstrate the MiG-31's ability to outrun the Tomcat to their US colleagues. It has to be admitted, though, that the *Foxhound* stands virtually no chances against the Tomcat in a dogfight, since the MiG-31's G limits and maximum turn and roll rates are much smaller than the F-14A's almost throughout the speed and altitude envelope.

On the other hand, the MiG-31's sustained turn characteristics at supersonic speeds in full afterburner (both in level flight and in a climb) are far superior to the F-14A's; in subsonic mode these characteristics are about equal. The MiG-31's sustained turn rate at speeds above Mach 1-1.2 and altitudes between 5,000 and 10,000 m (16,400-32,800 ft) are 50 to 100 per cent higher than the Tomcat's. Thus, in order to gain an advantage over the latter in horizontal and vertical manoeuvrability the MiG's crew needs to go supersonic first.

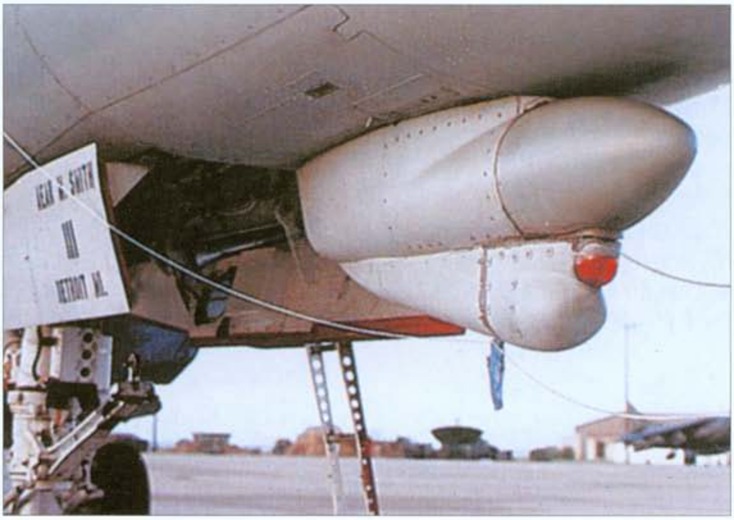
In constant-speed climbing manoeuvres the MiG-31 is superior to the F-14A in maximum bank angles, trajectory angle, turn and climb rates.

A comparison of the power characteristics, time required and tracks followed during

US Navy/World Art Power Journal

▲ **View from a tanker's aerial refuelling system operator's station as an F-14B in a temporary three-tone camouflage (applied with a broom!) nudges closer, preparing to make contact. Note the drop tanks on the additional hardpoints under the air intake trunks.**

The F-14's undernose pod houses the IRST and the AN/ALQ-100 ECM antenna. Note the red anti-collision light, a feature often found on Western fighters but not on Soviet ones. ▼



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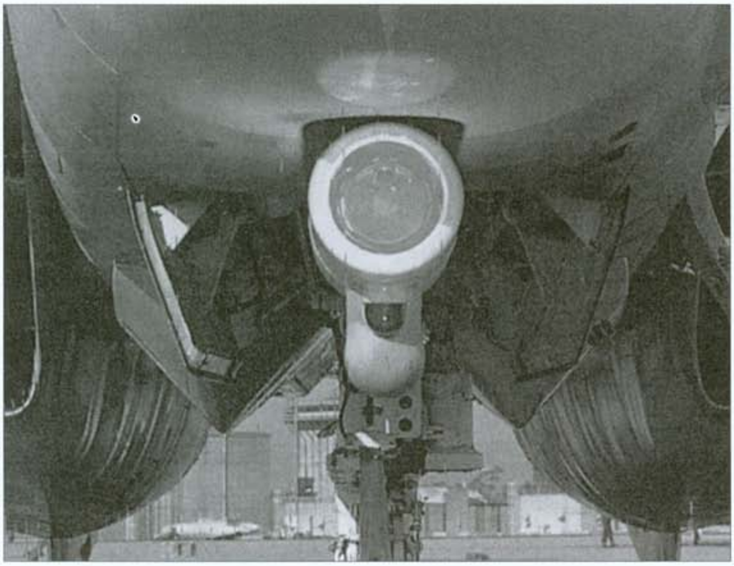

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▲ From 1982 onwards many F-14s were equipped with an AN/AXX-1 television camera set (TCS) under the nose for stand-off identification of aircraft not responding to IFF, with an AN/ALQ-126 jammer antenna underneath.

climb and acceleration shows that the MiG-31's ascendancy over the F-14 is achieved at the expense of a much higher fuel consumption. This comes as no surprise, since the Soviet fighter was designed for much higher speeds from the outset.

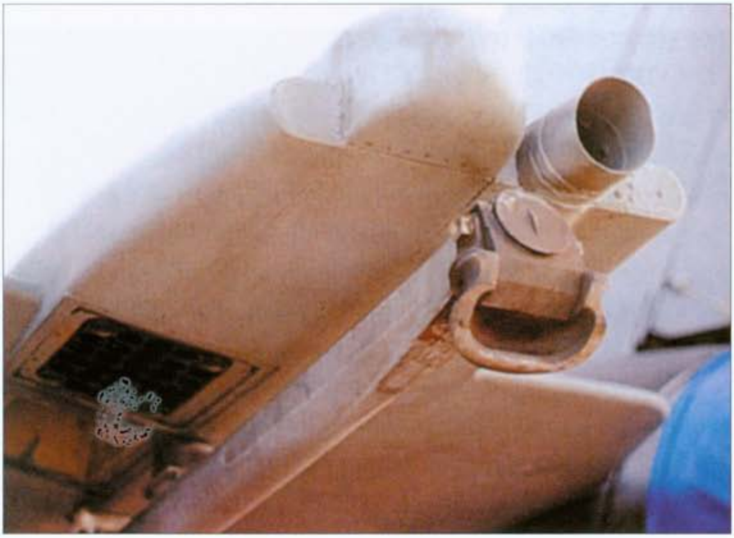
Of course, it is hard to say for sure whether the *Foxhound* was the catalyst, but it was exactly in the mid-1980s that Grumman Aerospace started work on upgrading the F-14A's powerplant; this effort resulted in the F-14A Plus powered by General Electric F110-GE-400s rated at 12,250 kgp (27,000 lbst) in full afterburner which entered flight test in September 1986. Even though the maximum total thrust was increased by nearly 30%, this did little to improve the fighter's maximum speed. This is probably due to the increased aerodynamic drag in the engines' inlet ducts and especially in the extension jetpipes which had to be lengthened by 1.27 m (4 ft 2 in) to accommodate the shorter F110 engines. On the other hand, acceleration and climb were improved dramatically. Suffice it to say that with an all-up weight of 25,500 kg (56,200 lb) the F-14B, as the F-14A Plus is known since May 1991, climbs to 18,000 m (59,050 ft) in just 50 seconds with maximum fuel but no external stores. By comparison, a similarly configured MiG-31 requires 7.9 minutes to reach 10,000 m (32,800 ft).

As already mentioned, clearly the Russian heavy fighter would be in for a hard time in close-in fighting for which it is not optimised. Still, let's imagine how the scenario would develop if the red-starred 'dog' and the American 'cat' engaged in a frightful free-for-all and analyse both fighters' efficiency in a dogfight. We would have to consider such factors as current thrust/weight ratio for each specific flight mode, wing loading, current lift/drag ratio (as a measure of the current Mach number and angle of attack) and permissible lift coefficient (as a measure of the permissible angle of attack).

The standard engagement conditions used for dogfighting efficiency comparison are an altitude of 3,000 m (9,840 ft), a speed of Mach 0.85, half-filled internal fuel tanks, four short-range air-to-air missiles and a full ammunition supply for the built-in cannon(s). The main factor characterising a fighter's efficiency in close-in combat is the G limit in a sustained turn. The higher, the better; this means the pilot can pull higher Gs and make tighter turns without a catastrophic drop in speed which would make the manoeuvre impossible.

It should be noted at once that the two fighters' G limit ratio is 1.48 in favour of the F-14B. In other words, if the MiG-31 enters a 4-G turn without losing speed, the F-14B can follow it, pulling 6 Gs – also without losing speed. Generally, a MiG-31 crew would be ill advised to enter a prolonged dogfight against the F-14B at high subsonic speeds where modern fighters make the most of their agility. In the rather unlikely event that the dogfight commences at supersonic speeds, when the manoeuvrability of any fighter leaves much to be desired, the superfast MiG-31 will have

The boat-tail fairing of an F-14D, showing the arrester hook, fuel jettison pipe, AN/ALQ-165 RHAWS antenna (in the domed fairing) and an AN/ALE-39 chaff/flare dispenser (with room for another). ▼



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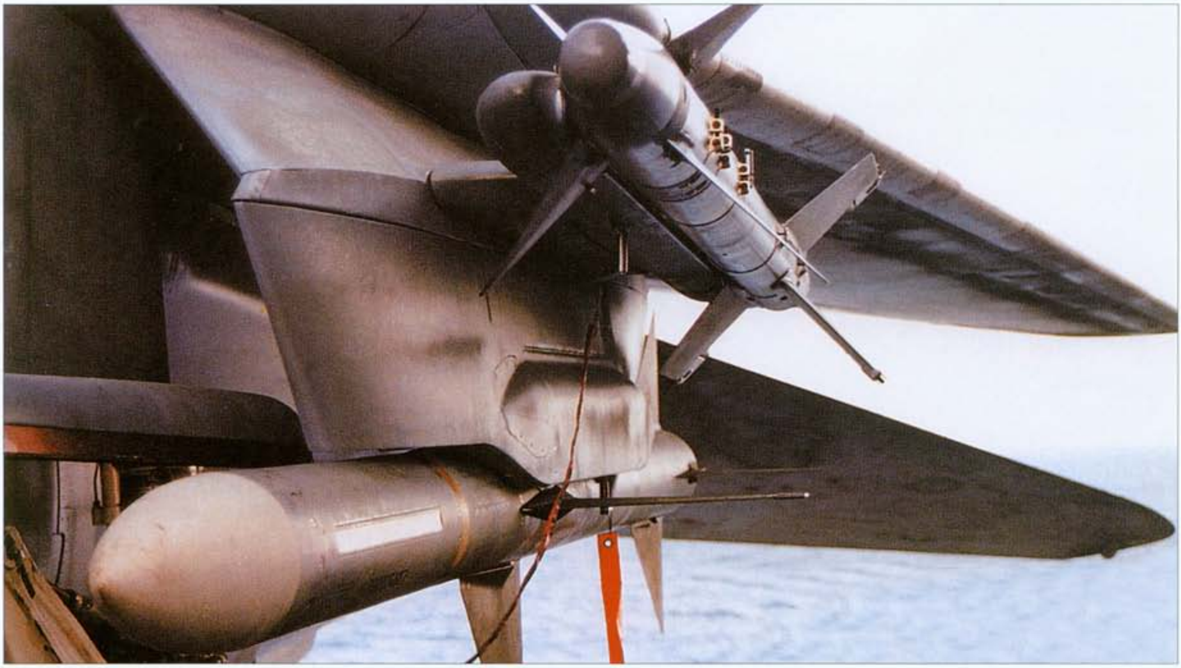

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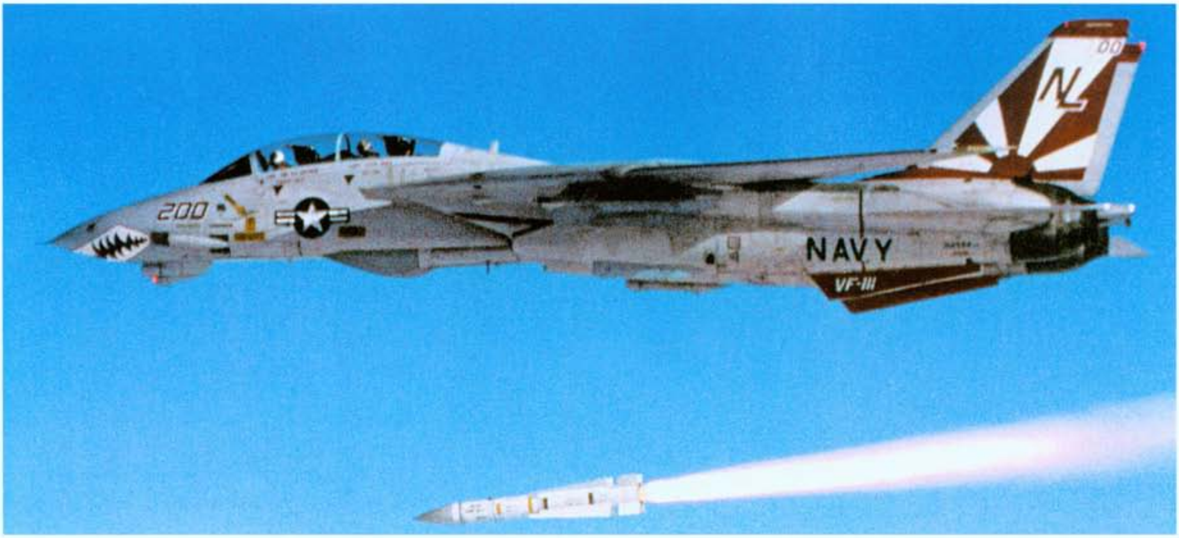
sustained turn characteristics which are only 10-15% lower than the Tomcat's and a lot will depend on the initial turn trajectory – at least at the beginning of the skirmish.

However, the probability of such a scenario is very low indeed. Consider that the agility of a fighter is highest at high subsonic speeds (which applies to the MiG-31 as well). If the dogfight begins at supersonic speeds, trying to maintain a high speed would be the worst mistake the MiG-31's crew could make; the adversary would surely try to slow down and his advantage in G limit would be even higher than the aforementioned figure of 1.48 times.

If you cannot get at your opponent's tail in sustained turns, and one or two tight turns 'on the spur of the moment' might prove decisive, the available G limits come into consideration. However, at high subsonic and supersonic speeds the available G limit is determined by

▲ **The port wing pylon of an F-14 (suitably kinked to clear the main gear door) carries an ejector rack for an AIM-7 and a launch rail for an AIM-9 Sidewinder IR-homing missile.**

F-14A-125-GR BuNo 161621/ NL-200 of VF-111 'Sundowners' lets loose with an AIM-54C. ▼



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A live R-40TD medium-range heat-seeking missile under the starboard wing of a MiG-31.

the fighter's operational G limit which is 7.5 for all versions of the F-14 and 5.0 for the MiG-31 (that is, the ratio is again 1.5 in favour of the Tomcat).

Also, in supersonic mode the F-14 can have a higher wing sweep than the MiG-31 (68° versus 41°). This means the American interceptor has higher induced drag, which allows it to bleed off excessive speed quicker and initiate a tighter turn.

A comparison of the available G limits at speed between Mach 0.3 and Mach 0.6 also gives a ratio of 1.47 in favour of the F-14B. Thus it is highly inadvisable for the MiG pilot to initiate a series of manoeuvres below Mach 0.6, as it causes the Mach 3 fighter to lose speed abruptly and far more rapidly than the adversary. This rapid loss of speed and the onset of critical angles of attack may prove fatal for such a large and sluggish aircraft.

The port wing pylon of this MiG-31 carries an APU-60-2 adapter for two R-60M short-range heat-seeking AAMs. The variance in the colour of the two missiles' seeker heads is noteworthy.

Yefim Gordon

The MiG-31 is not compatible with the R-73 short-range AAM; for close encounters it is armed with the less sophisticated R-60M heat-seeking AAMs which are inferior both to the R-73 and to the AIM-9M Sidewinder in terms of power/ballistics, agility and infra-red countermeasures resistance. As it is, the R-60M no longer meets current requirements regarding all-aspect engagement capability; as compared to state-of-the-art 'dogfight missiles' it may be termed as having limited all-aspect engagement capability (it is intended for self-defence or for attacking low-manoeuvrability targets at close range).

In a nutshell, dogfighting is expressly not recommended for *Foxhound* crews, and the crew's best choice is a 'hit-and-run' tactic – to make a U-turn and depart in full afterburner before they come within range of the adversary's weapons if the MiG-31 fails to score a 'kill' at long range.

Weapons Control Systems Compared

Since the MiG-31 and the F-14A are both long-range fast interceptors, they are both intended mainly for beyond visual range (BVR) missile attacks against large aerial targets such as bombers, transports, airborne early warning and control (AEW&C) aircraft, aerial refuelling tankers and so on. The results of BVR combat depend largely on the performance of the interceptor's mission avionics suite (target acquisition and lock-on range, target tracking stability and ECM resistance), as well as on the performance of its long- and medium-range AAMs. Interception range is another crucial parameter; this is where the interceptor's speed, rate of climb (time to height) and acceleration time to high Mach numbers come into the picture.

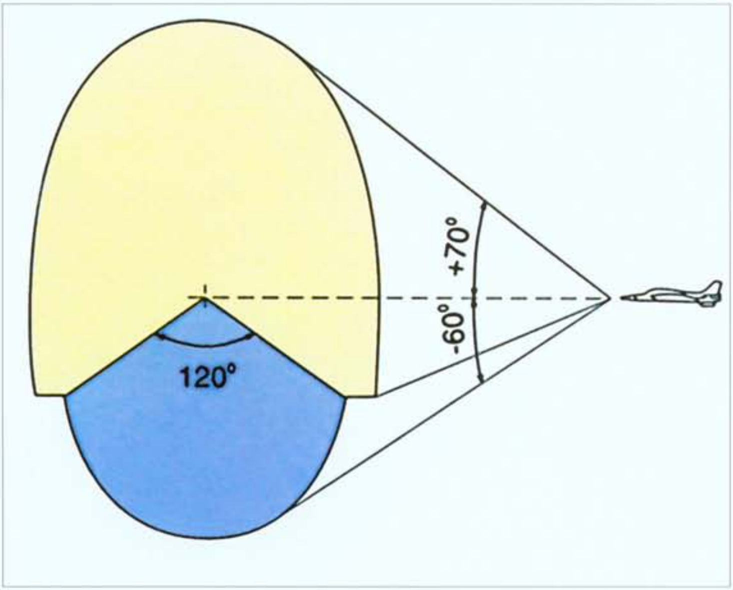
It should be noted that the performance figures of the F-14's AN/AWG-9 fire control radar published in the Western aeronautical press in the mid-1970s were positively staggering. The specified target acquisition range in head-on mode was no less than 315 km (195 miles); the radar was reportedly capable of tracking 24 targets while guiding missiles to six priority threats! Later, however, the Western media published a more modest guaranteed 'kill' range figure of 185 km (115 miles).

At a glance, the performance of the MiG-31's Model 8B radar appears far less impressive, with an acquisition range in head-on mode of only 130 km (80.75 miles) and a capability to track ten targets while attacking six priority threats. It is also heavier than the

American radar. Yet, don't let's make hasty conclusions. The major difference between the two radars lies in the antenna design – that is, the beam scanning principle employed. The mechanically scanned antenna of the AN/AWG-9 allows the radar to either scan the airspace ahead according to a preset programme, tracking targets intermittently as it moves, or to track a single selected target continuously. In contrast, the phased-array antenna of the Model 8B radar making up part of the RP-31 (Zaslon) weapons control system allows the beam to be moved almost instantly to any given point of the radar's field of view.

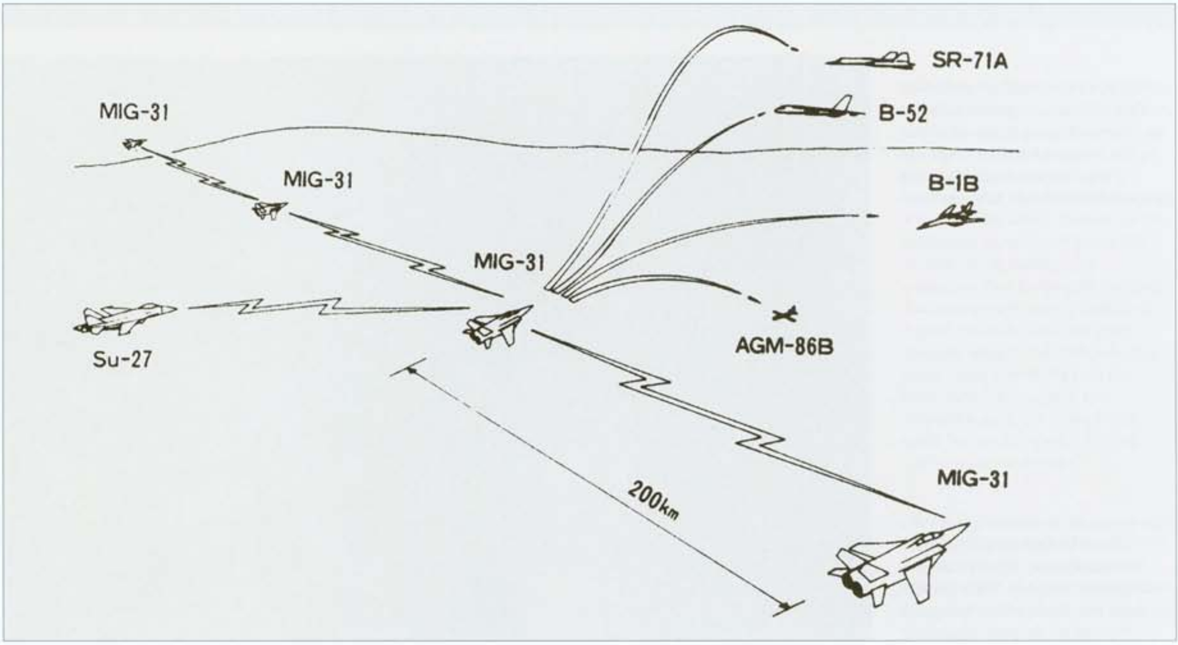
The difference in antenna types has influenced the overall structure of the AN/AWG-9 and RP-31 (Zaslon) weapons control systems. Since the former's mechanically scanned antenna cannot provide for simultaneous illumination of several targets is such a way as to allow terminal guidance of the missiles, the Hughes Aircraft company utilised semi-active/active radar homing seeker heads on the AIM-54A and AIM-54C to provide multiple target attack capability. In contrast, the Zaslon WCS utilises only semi-active radar homing when attacking multiple targets. The electronically scanned beam ensures the required target illumination time.

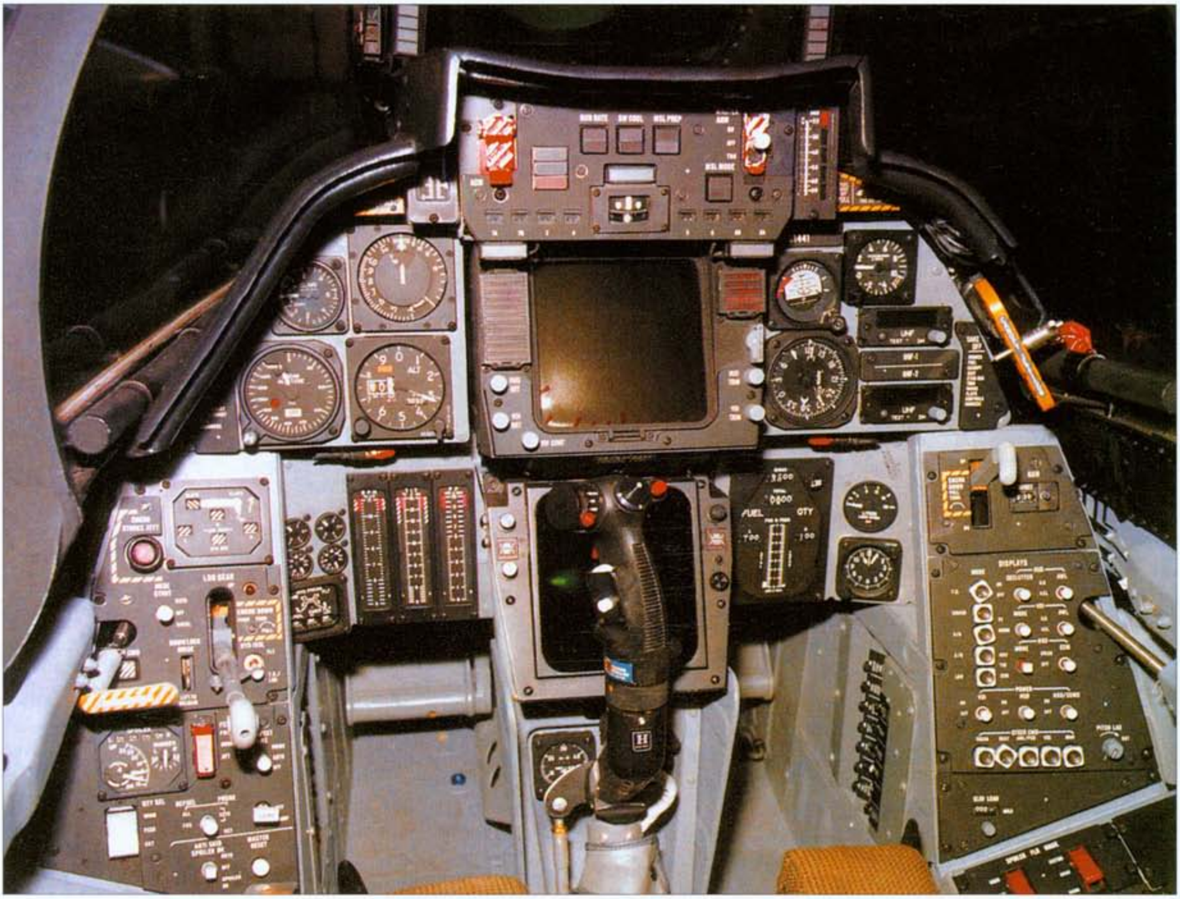
It should be noted that the AN/AWG-9's advertised acquisition range applies to bomber-type targets with a radar cross-section of 15-20 m² (161.3-215.0 sq ft). Smaller aircraft (that is, fighter-type targets) with an RCS of 3-5 m² (32.25-53.76 sq ft) can only be detected by the American radar at a maximum distance of 130-140 km (80.75-87 miles), which is much the same as for the Russian radar. By comparison, a target with an RCS of 10 m² (107.5 sq ft) is detected by the MiG-31's radar at up to 280 km (174 miles).



▲
This diagram illustrates the field of view of the MiG-31's Model 8B fire control radar.

Besides attacking aerial targets on its own, the MiG-31 can pass target information to 'friendly' fighters at up to 200 km (124 miles) range.
▼





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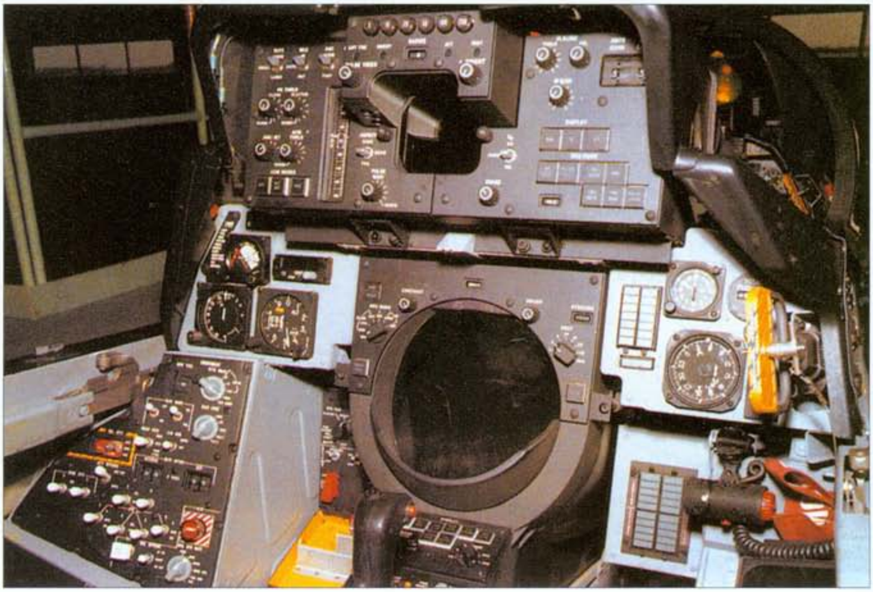
The pilot's cockpit of an F-14A. The instrument panel features two large displays, one of which is the Vertical Display Indicator (VDI). Note the vertical strip gauges to the left of the displays.



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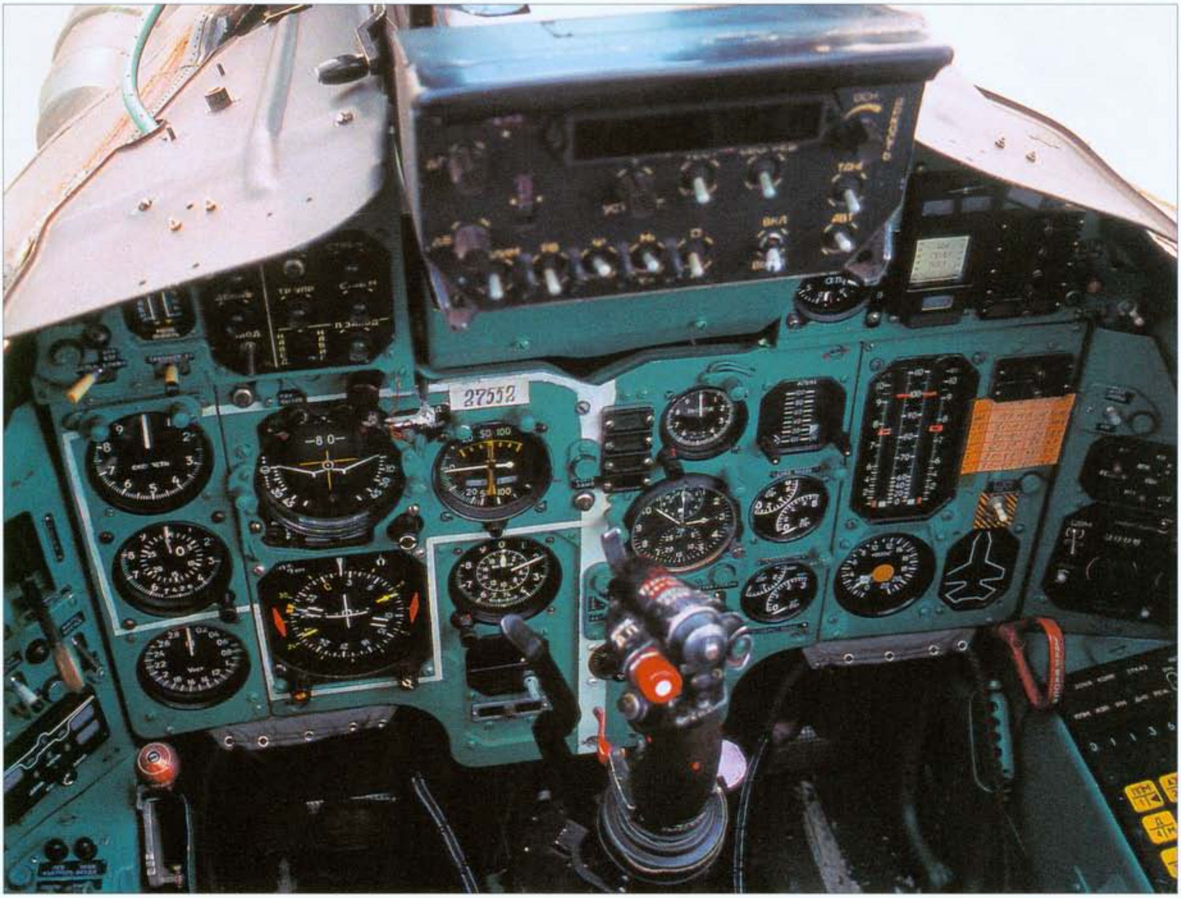
The weapons systems operator's workstation of the F-14A is dominated by the Tactical Situation Display, with a detail data display and the weapons selector panel above it.



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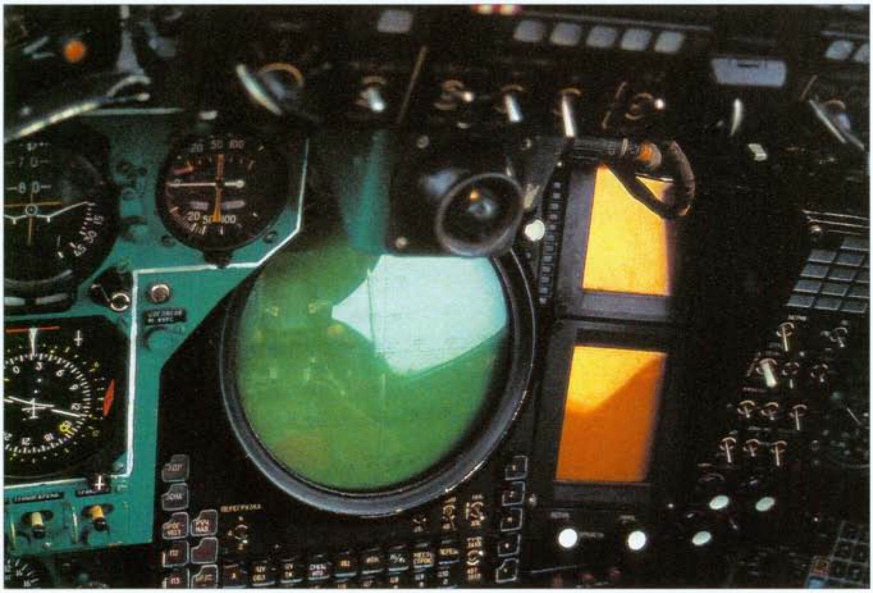
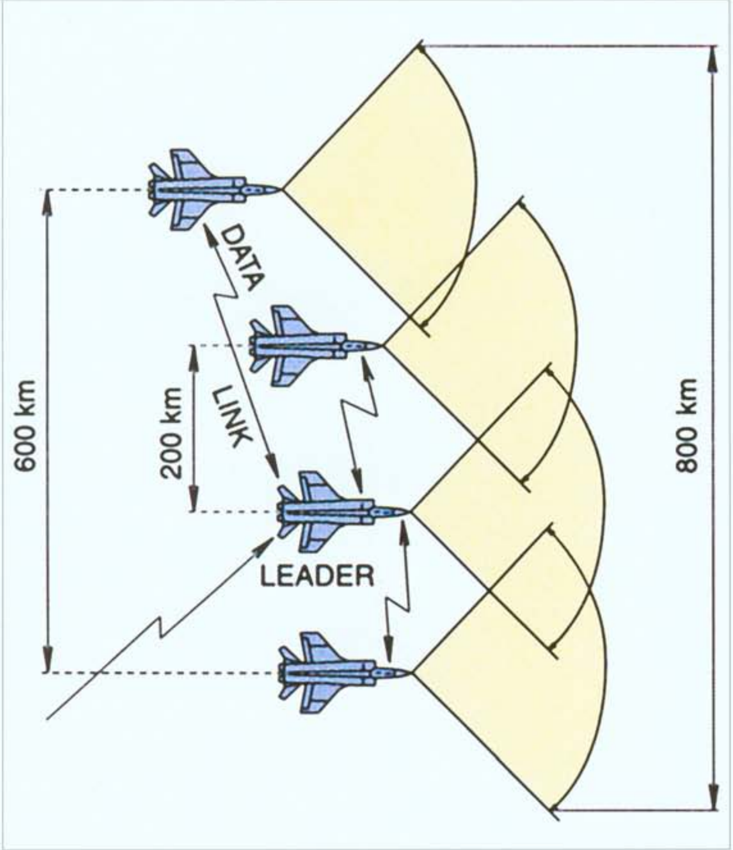


Yefim Gordon

▲
In comparison, the MiG-31's front cockpit appears unsophisticated, with conventional electro-mechanical instruments throughout; the primary flight instruments are grouped in a neat T shape. The white line down the middle is used for aligning the control stick during spin recovery. The turquoise colour of the instrument panel, typical of Soviet aircraft, reduces pilot fatigue, easing the strain on the eyes. Note the sticker on the instrument panel with the aircraft's callsign (RA-27552) used for working with civil air traffic control centres.

◄
The WSO's cockpit of the MiG-31 has a centrally mounted radar display, with the tactical situation displays on the right and back-up flight instruments on the left.



▲ **This diagram shows how a flight of four MiG-31s can keep a strip up to 800 km (500 miles) wide under control.**

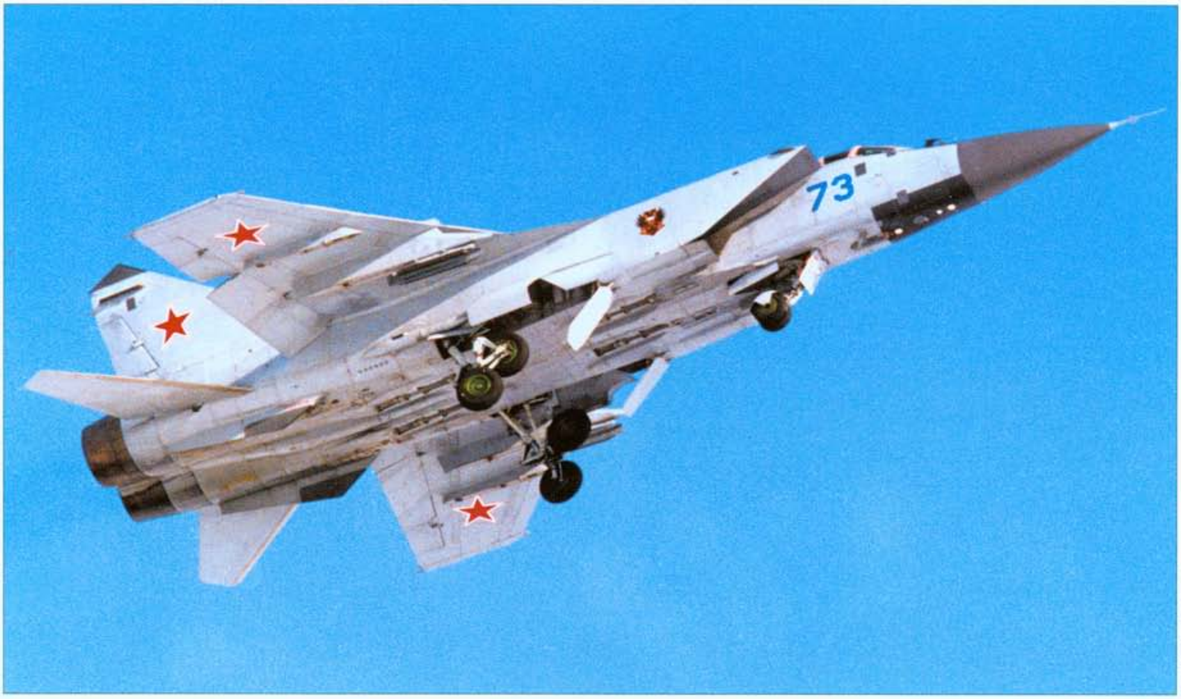
Also, even though the Model 8B radar has shorter potential detection range than its US counterpart, the electronic beam scanning compensates for the difference in range during target tracking. For all practical purposes the two weapons control systems have identical target tracking/weapons guidance range. However, the Model 8B radar's phased-array antenna gives it a truly overwhelming advantage as regards the multiple target tracking and engagement area. The orthogonal projection of the radar's field of view is only 420 square degrees for the American radar versus 18,200 sq deg for the Soviet unit! This of course means it takes a much larger number of Tomcats than of *Foxhounds* to defend an area of a given size. It is equally obvious that in the same tactical situation the MiG-31 will be capable of attacking a lot more targets than the F-14A.

Due to the different scanning methods employed the two radars utilise different data processing methods during target detection and target range/angle co-ordinate measurement. It should be noted that the Model 8B radar's accuracy in measuring these parameters is several times higher than the AN/AWG-9's. This accounts for the fact that US Navy F-14s never managed to score a 'kill' with their Phoenix missiles in actual combat against Libyan aircraft during the skirmishes in the Gulf of Sidra in 1982-84 and against Iraqi aircraft during operations *Desert Storm* (1991) and *Desert Fox* (1999). In the latter case a pair of F-14Ds fired two AIM-54Cs at a pair of Iraqi Air Force MiG-25P interceptors which, unsurprisingly, successfully evaded the missiles.

The reason for this embarrassing performance is evident; by fitting a radar with rather limited capabilities (due to the emitter's low power and hence limited range and a small field of view) the designers of the AIM-54 succeeded only in achieving a price hike but not an improvement in efficiency. As the AIM-54's seeker head goes from semi-active to active radar homing mode, the target aircraft's RHAWS usually gives the pilot timely warning that the type of radar threat has changed. The target then immediately turns on a reciprocal heading, losing altitude and causing the AIM-54 to lose lock-on immediately; the seeker head's narrow field of view leaves the missile no chances of tracking the target.

The constant SARH principle used by the Model 8B radar in conjunction with the R-33 missile offers far greater advantages, since the missiles fired by the MiG-31 are constantly controlled by the interceptor's armament control system. The F-14 appears to have run into problems with its advertised multiple target tracking/attack capability; there is no other explanation of the fact that all USN Tomcats currently in service have had their AN/AWG-9 radars replaced with AN/APG-71 radars capable of tracking only ten targets while guiding missiles to eight priority threats. The AN/APG-71's capabilities are similar to those of the upgraded Russian radar forming part of the experimental MiG-31M interceptor's RP-31M (Zaslon-M) WCS. In the course of trials the MiG-31M demonstrated its ability to shoot down low-flying targets (cruise missiles) at 280 km (174 miles) range! As for the AN/AWG-9, trials showed its inability to successfully guide missiles to more than two targets at a time, which again is explained by poor accuracy in determining the targets' current co-ordinates.

Speaking of which, it was exactly this factor that led the American designers to reduce the AIM-54C's maximum launch range to 150



Vyacheslav Martyniuk

km (93 miles). This range is achieved by giving the missile a maximum speed of Mach 6. The Soviet interceptor cannot boast such a long reach: the R-33 has a maximum launch range of 120 km (74.5 miles), accelerating to Mach 3.5-4. On the other hand, the American missile's high speed does not give it any tangible advantage over the Soviet one; while having a similar launch weight to the R-33 (463 kg/1,020 lb and 480 kg/1,058 lb respectively), the AIM-54 is powered by a solid-fuel rocket motor offering the largest possible impulse but a very short burn time. This effectively means the motor burns out at the crucial moment of the attack, the missile being propelled towards the target at the terminal guidance stage by inertia alone. If the target as much as starts climbing, the chances of a 'kill' are obviously greatly diminished; if the target unleashes electronic countermeasures or takes evasive action, 'kill' probability starts approaching zero.

Now, the power and ballistic parameters of the upgraded Russian R-33S AAM used on the upgraded MiG-31B and MiG-31BS have been improved vastly. Suffice it to say that during trials in the summer of 1989 the R-33S showed a substantial improvement over the baseline R-33 *sans suffixe* in both 'kill' range and 'kill' altitude. In fact, the altitude results were so unexpectedly impressive that the Soviet Air Force and Air Defence Force General Headquarters representatives would not believe them until they received the official range instrumentation data readouts.

It has to be said, however, that the Tomcat's punch has been vastly increased by the integration of the AIM-120 AMRAAM (Advanced Medium-Range Air-to-Air Missile) featuring active radar homing. The AMRAAM decidedly outclasses the R-40TD which is the MiG-31's medium-range weapon. True enough, Russia has a similar missile – the R-77 (aka RVV-AE), dubbed 'Amraamski' in the West, but no information is forthcoming about this weapon being fielded in any quantity

▲
A Russian Air Force MiG-31 tucks up its undercarriage a few seconds after becoming airborne from Savasleyka AB. No external stores are carried on the eight hardpoints, although the inboard wing pylons carry APU-60-2 racks. Note how the main gear bogies somersault as they retract; note also the unit badge on the air intake.

MiG-31 '51 Blue' flies with the airbrakes partly open to keep formation with the camera ship.
▼

Vyacheslav Martyniuk

VF-124/World Air Power Journal

▲ **US Navy fighters often wear striking colour schemes, as illustrated by this pair of F-14As operated by VF-124 'Gunfighters' from USS *Nimitz*. Note the anti-collision lights under the nose and at the fin tips (port, front; starboard, rear) positioned to provide full 360° coverage.**

worth mentioning. Likewise, no proof is available so far of the R-77 being integrated on the MiG-31 as part of a mid-life update, despite the many claims from RSK MiG and the Russian Ministry of Defence that the upgraded MiG-31BM is capable of carrying up to four of these missiles on underwing pylons.

A few words need to be said about the components of both interceptors' weapons control systems. The infra-red search & track units (the *Foxhound*'s Model 8TP and the Tomcat's JR) share the same operational modes: autonomous mode, joint operation with the radar, search, single-target tracking and built-in test mode. Neither IRST is capable of tracking several targets at once. The JR automatically defines the number of targets within the radar's resolution limits; the Soviet 8TP is capable of showing the number of targets only in visual mode.

The mission is handled by the AWG-9's digital data processing system utilising several specialised analogue processors, the CDC-5400B digital mainframe computer and a system of interfaces. The digital data processing system of the RP-31 (Zaslon) WCS includes the Argon-15 digital mainframe computer with an input-output device and specialised digital/analogue modules performing preliminary processing of the data supplied by the radar and the IRST. Both systems obviously utilise an hierarchical structure and share the same design principle.

A comparison of the CDC-5400B and Argon-15 mainframe computers shows that the former is superior in such aspects as processor speed and memory. On the whole, however, the weapons control systems of the MiG-31 and the F-14 have broadly comparable performance. Where the Soviet system lags behind is primarily in size and weight (the Argon-15 mainframe computer is bulkier and heavier) and in the parameters of the visual display system. This is largely compensated by the higher capabilities of the phased-array radar and the appropriate target data processing capability in single-target mode; in multiple target mode the MiG-31's radar actually has better performance than the F-14's.

Combat Capabilities and Efficiency

The aerial intercept systems built around the MiG-31 and the F-14 are designed to fulfil a wide range of missions associated with destroying hostile aerial vehicles. In the case of both fighters, the two main missions are the interception of aerial targets within a wide speed and altitude range, regardless of the target's evasive action and electronic countermeasures, and destruction of enemy fighters in beyond-visual-range combat.

One of an aerial intercept system's key parameters is the interception zone (the area within which the aircraft can destroy incoming targets at average range with the required 'kill' probability). Considering all of the above, it is obvious that the upgraded MiG-31 surpasses the Tomcat as far as target speeds are concerned, especially in pursuit mode, thanks to its wider speed envelope. On the other hand, the F-14 comes out on top as far as target altitude is concerned thanks to the AIM-54 Phoenix missile's higher G limits. It has to be said, though, that the F-14 is markedly inferior in a head-on BVR missile engagement when flying above, or at the same altitude as, the MiG-31. This is due to the latter's larger multiple target attack zone and longer launch range of the upgraded R-33S missile, which gives the MiG-31 ascendancy in medium- to long-range combat.

An aerial intercept system's combat potential may be regarded an integrated parameter of its efficiency. The combat potential is regarded as the ratio of the number of aircraft used to fulfil a given mission to the number of aircraft lost to enemy action, providing the latter does not exceed a specified limit (after all, every 'friendly' aircraft lost is one too many!). The combat potential may also be assessed as the kill-to-loss ratio during a mission. According to estimates made by the Russian MoD's 2nd Central Research Institute, the combat potential of the F-14A equals 60-70% of the MiG-31's combat potential.

Yefim Gordon

▲
Three MiG-31Bs pass over Moscow in Vee formation on 9th May 1995 during the grand parade on occasion of the 50th VE-Day anniversary.

A pair of MiG-31Bs from Savasleyka cruises over the Russian countryside near Nizhniy Novgorod.
▼

Vyacheslav Martyniuk

A Comparison of Certain Performance Parameters of the Two Aircraft

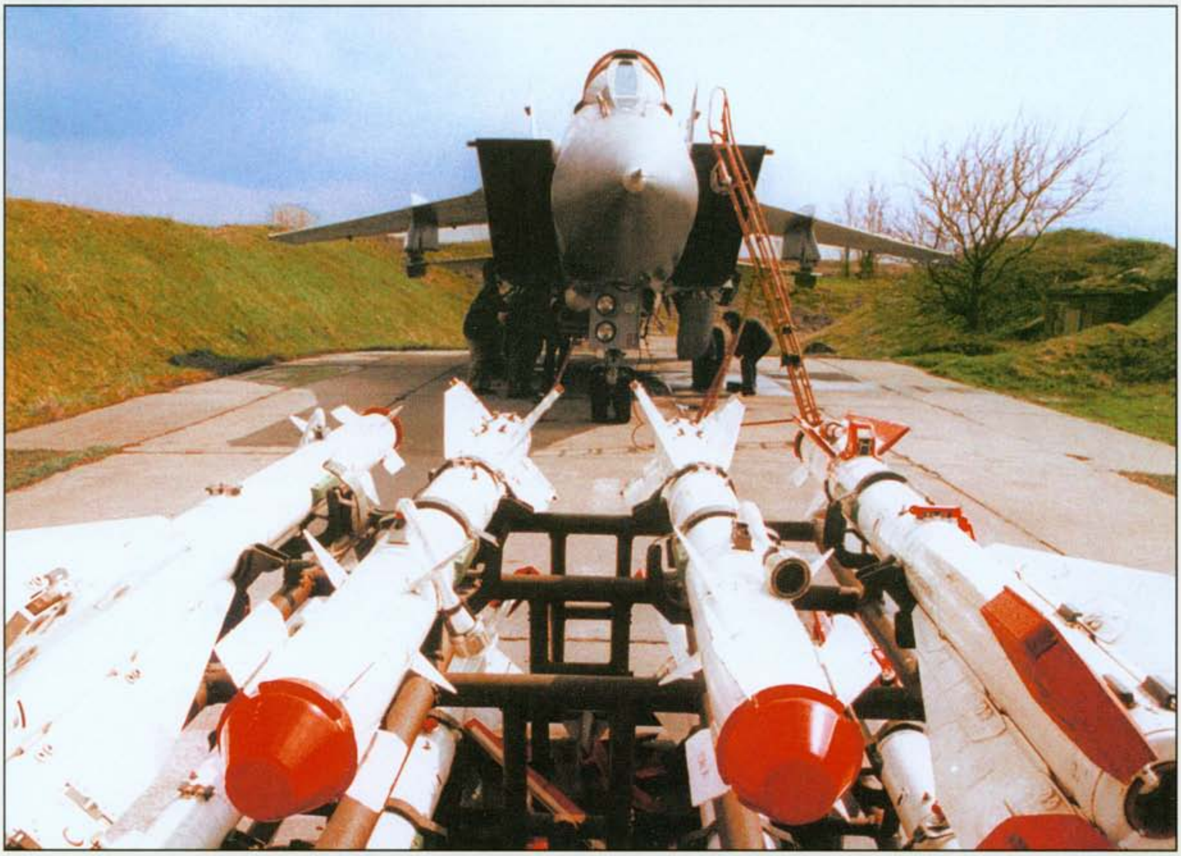
	MiG-31	**F-14A**
Powerplant	2 x Solov'yov D30F-6	2 x Pratt & Whitney TF30-P-412A
Thrust, kgp (lbst):		
dry	9,500 (20,940)	5,600 (12,345)
reheat	15,500 (34,170)	9,480 (20.900)
Internal fuel supply, kg (lb)	15,500 (34,170)	7,460 (16,446)
Maximum take-off weight, kg (lb)	41,000-43,000 (90,390-94,800)	31,000-33,000 (68,340-72,750)
Thrust/weight ratio at take-off	0.76	0.72
Maximum speed, km/h (mph):		
at sea level	1,450 (900)	1,450 (900)
at altitude	3,000 (1,863)	2,350 (1,460)
Minimum control speed, km/h (mph)	450 (281)	400 (250)
Service ceiling, m (ft)	20,600 (67,580)	18,500 (60,690)
G limit	5	7.5
Target interception range on internal fuel, km (miles):		
in afterburner mode	720 (447) at Mach 2.35	250 (155) at Mach 1.5
at full military power	1,250 (776) at Mach 0.8	800 (497) at Mach 0.8
Weapons control system	RP-31 (Zaslon)	AN/AWG-9
Radar antenna	Phased array	Slotted array
Bean scanning range:		
azimuth	±70°	±65°
elevation	+70°/-60°	±60°
Number of targets tracked at a time	10	24
Number of targets attacked at a time	4	6
Multiple target tracking zone, sq deg	18,200	420
Fighter-type target* detection range, km (miles):		
head-on mode	120-130 (74.5-80.75)	130-140 (80.75-87) †
pursuit mode	45-60 (28-37.25)	60 (37.25)
WCS data displays:		
pilot's cockpit	PPI-70V HUD, ITO-L tactical info display	HUD, 2 tactical info displays
WSO's cockpit	tactical info display, overview display	2 cathode-ray tube displays
Mainframe computer	Argon-15	CDC-5400B
IRST system	8TP	JR
Armament control system	SUO-31	AN/ASN-92
ECM/ESM suite:		
radar homing and warning system	Beryoza-ML	AN/ALR-45
chaff/flare dispensers	APP-50	AN/ALE-39
active jammer	–	AN/ALQ-126
Command/data link equipment	APD-518, KRU	ASW-27
Armament:		
long-range AAMs	4 x R-33	6 ı AIM-54A Falcon
medium-range AAMs	2 x R-40TD	6 ı AIM-7F/E Sparrow
short-range AAMs	4 x R-60M	2 ı AIM-9 Sidewinder
cannon (calibre, mm/no. of rounds)	Gryazev/Shipoonov GSh-6-23 (23/260)	General Electric M61A1 Vulcan (20/675)
bombs	–	14 x Mk 84

* Radar cross-section 3 m^2 (32.25 sq ft); † Some sources state the AN/AWG-9's acquisition range as 240 km (149 miles)

PART FIVE

STRUCTURAL DESIGN, SYSTEMS & ARMAMENT

The MiG-31 in Detail



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Type

Twin-engined two-seat heavy interceptor.

Structurally the MiG-31's airframe is broadly similar to that of the MiG-25. Part of the structure is made of aluminium alloys capable of withstanding operating temperatures of 150°C (300°F); areas subject to strong kinetic heating at supersonic speeds are made of titanium and stainless steel. The latter material accounts for 50% of the structure, with titanium and aluminium making up 16% and 33% respectively; the remaining 1% is other materials. The structural elements are mostly joined by automatic and semi-automatic spot welding and argon-arc welding.

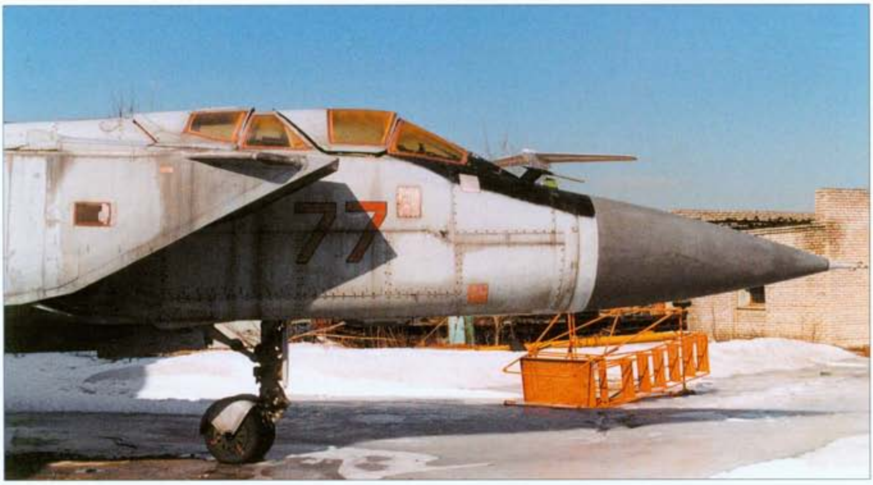
Fuselage

Monocoque stressed-skin structure with a cross-section changing from circular (at the front) to oval with the longer axis vertical (in the cockpit area) to almost rectangular (near the air intakes) to oval with the longer axis horizontal. The fuselage features a detachable conical dielectric radome and numerous removable or hinged access panels for engine and equipment servicing. Overall length 20.62 m (67 ft 7$^{7}/_{8}$ in), maximum cross-section area 5.7 m^2 (61.3 sq ft).

Technologically the fuselage consists of numerous welded and riveted panels and is divided into the forward fuselage (nose probe to frame 3) which includes the cockpit section, the avionics bay aft of the cockpits (frames 3-4), the air intake section (frames 2-6), the fuel tank bay (frames 4-12), the aft fuselage (frames 12-14) which incorporates the engine bays, and the tailcone aft of frame 14. The fuselage has 57 frames and webs; the principal load-bearing frames are Nos 1 to 6, 6B, 7, 9, 10, 10A, and 11 through 14.

The fuselage structure is made of VNS-2, VNS-5, EI-878, SN-3 EI-703, VNL-3 and VL-1 high-strength stainless steels, D19 and VAL-10 high-strength aluminium alloys, and OT4-1, VT-20, VT-21L and VT-22 high-strength titanium alloys.

The *forward fuselage* up to frame No 4 is made chiefly of riveted aluminium and includes a dielectric radome, a radar set bay (web No 1 to frame No 1), the cockpits (frames 1-3) and an avionics bay (frames 3-4).



Yefim Gordon

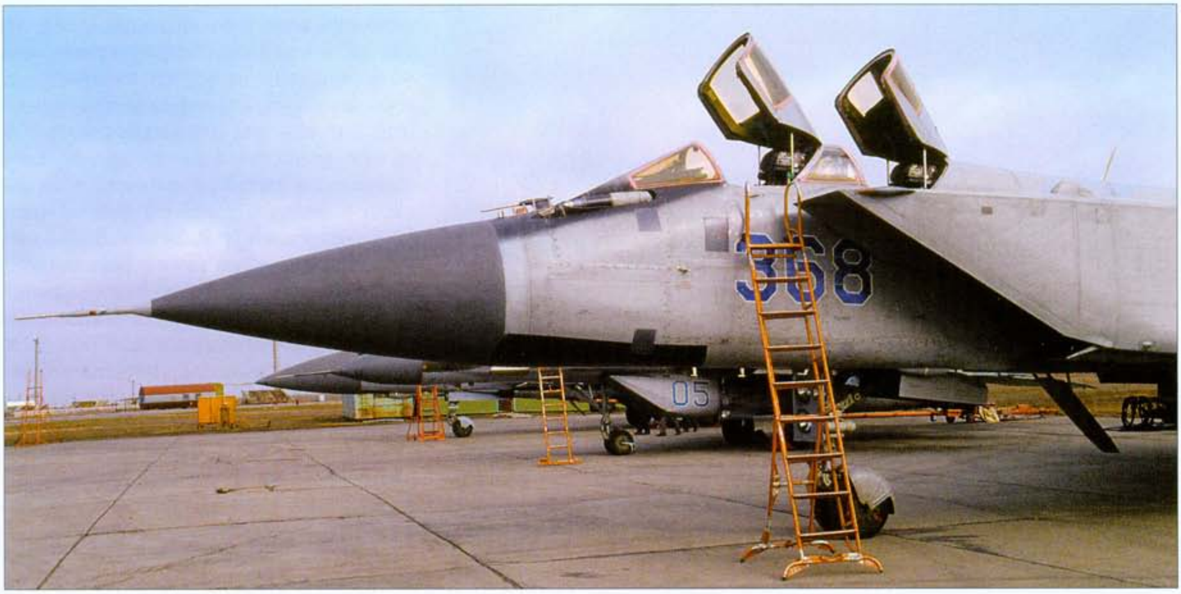
◄
The forward fuselage of a MiG-31. The small dielectric panels near the cockpit are unpainted here.

The tandem cockpits are pressurised and fitted with ejection seats. They are enclosed by a common canopy with individual aft-hinged sections which can be partially opened at taxying speeds up to 30 km/h (18 mph). The WSO's canopy has a retractable forward vision periscope enabling him to fly and land the aircraft. The windshield side quadrants, the glazing of the hinged sections and of the section in between are made of 10-mm ($^{13}/_{32}$ in) SO-200 heat-resistant Plexiglas (*stek**lo** orga**nich**eskoye*). The optically flat birdproof windscreen is a 36-mm (1$^{13}/_{32}$ in) sandwich of three layers of silica glass with electric de-icer film.

The cockpits are separated by a sloping bulkhead (frame 2) and a 10-mm panel of AO-120 Plexiglas. The aft cockpit terminates in a likewise sloping bulkhead (frame 3); the bulkheads serve as attachment points for the ejection seat rails.

The detachable fibreglass radome is attached to web No.1 by nuts and bolts. Bays below and aft of the cockpits house navigation and communications equipment, as well as part of the electric system components. The nosewheel well is located between frames 1A and 3V. The fuselage sides incorporate attachments for the air intakes and crane handling lugs.

The nose of MiG-31 f/n 3608, showing the stowed IFR probe.
▼



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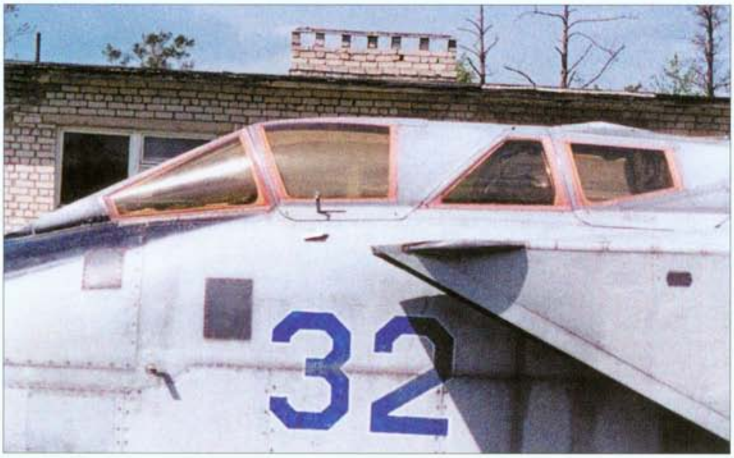
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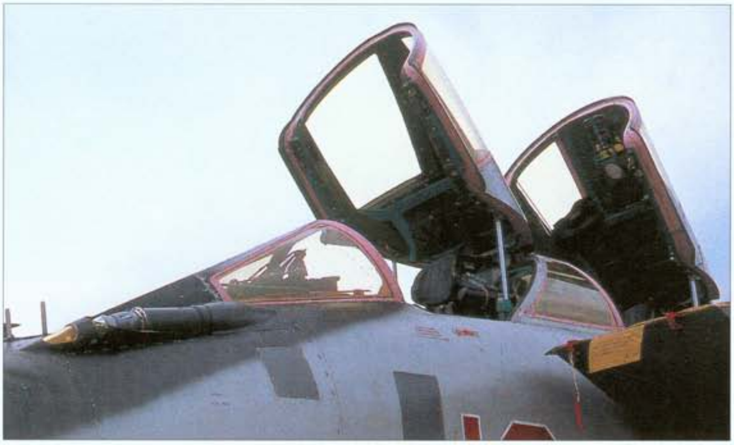
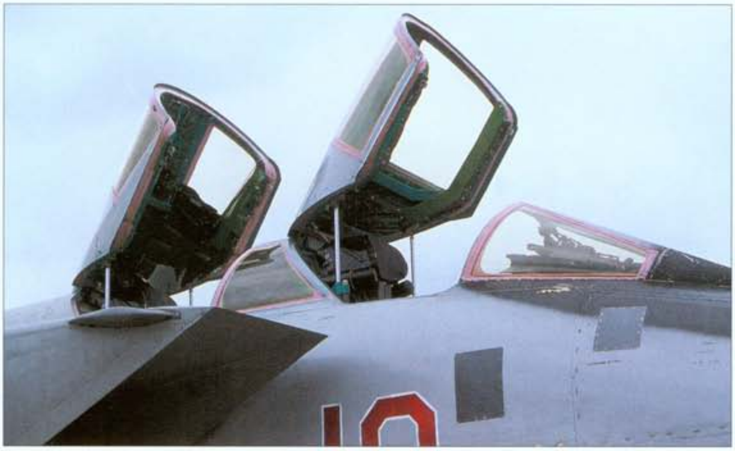
▲ **The cockpits of a probeless MiG-31 (*izdeliye* 01) with both canopies closed.**


Yefim Gordon

▲ **The cockpits of an IFR-capable MiG-31 (*izdeliye* 01DZ) with both canopies open.**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▲ **Another view of the open canopies. Each canopy is actuated by twin hydraulic rams.**

The *centre fuselage* section between frames 4 and 12 is a welded structure of high-strength stainless steel incorporating attachments for the wings, air intakes, main gear units, engines, fins and missile ejector racks.

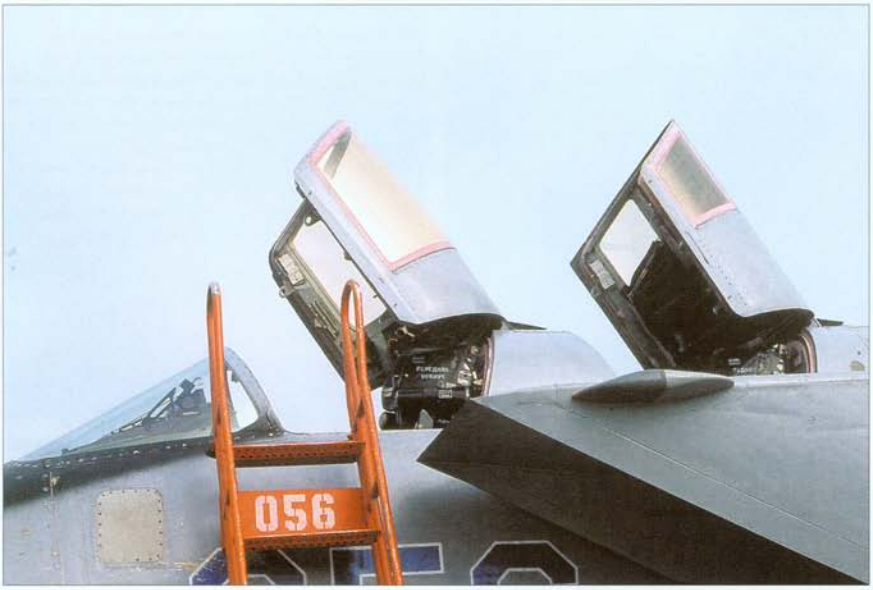
The MiG-31's air intakes are much larger and more complex than those of the MiG-25. They are stressed-skin structures with load-bearing removable panels. The inlet ducts start at frame 2 and extend along the fuselage sides to frame 6; the cross-section changes from rectangular at the front to circular between frames 6 and 7 (at the engine compressor faces). The air intakes have sharp lips, the side panels slanting aft in profile. Intake cross-section is adjusted by movable lower lips and horizontal flow control ramps to ensure stable engine operation throughout the speed and altitude envelope. The ramps' actuators are controlled by the ARV-27 automatic intake control system (*avto**maht** regoo**lee**rovaniya **voz**dookhoza**bor**nika*).

The upper part of the centre fuselage and the space above the inlet ducts house seven integral fuel tanks (this portion of the fuselage is referred to as the fuel tank section). The lower centre fuselage houses fuel system components.

The centre fuselage (fuel tank section) is the section subject to the greatest stress and strain, as it is it absorbs the load from the wings, tail unit (via the aft fuselage) and landing gear, as well as the external aerodynamic loads and the air pressure in the inlet ducts and fuel tanks. It is the main structural component the entire airframe is built around. The fuel tank section incorporates ten mainframes (Nos 4 to 6, 6B, 7, 9, 10, 10A, 11 and 12) and is made of high strength stainless steel (grades VNS-2, EI-878, VNS-5, SN-3 and VNL-3).

The gradually tapering fuselage spine housing the control runs extends from the cockpit canopy to the brake parachute container. Hydraulic, pneumatic and air-conditioning equipment is located in bays along the fuselage sides.

The *rear fuselage* incorporates attachment points for the fins and stabilators (frames 13 and 14), as well as for the afterburners; it also accommodates some engine accessories. Three equipment bays faced with ATM-3 heat insulation are located in the upper aft fuselage between frames 12-13, 13-14 and 14B-14V. These house control system, fuel system and hydraulic system components. The tailcone consists of a centrebody welded from EI-703 steel and a detachable outer portion.



Yefim Gordon

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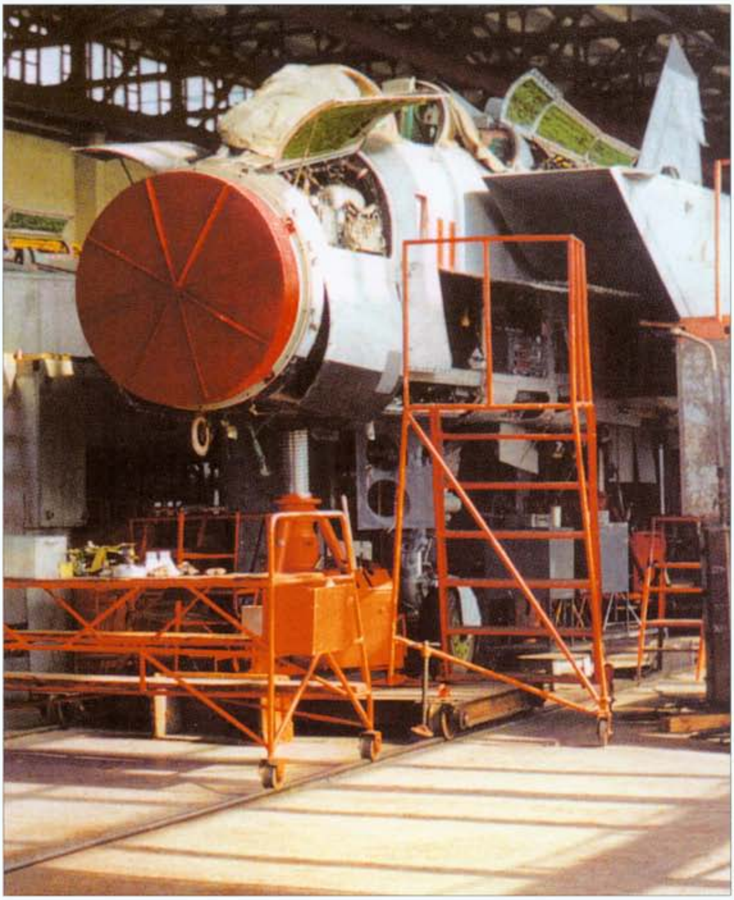
The cockpits of MiG-31M '056 Blue'. The one-piece curved windscreen is clearly visible. The glazing area is increased in the front cockpit but reduced in the rear cockpit, as there is no longer any provision for the back-seater to fly the aircraft.

'11 Red', a probeless MiG-31 (*izdeliye* 01), undergoes refurbishment; every access panel and port on the fuselage is open for inspection. Note the green heat insulation blankets on the insides of the avionics bays' access panels.

▼



Air Fleet Herald

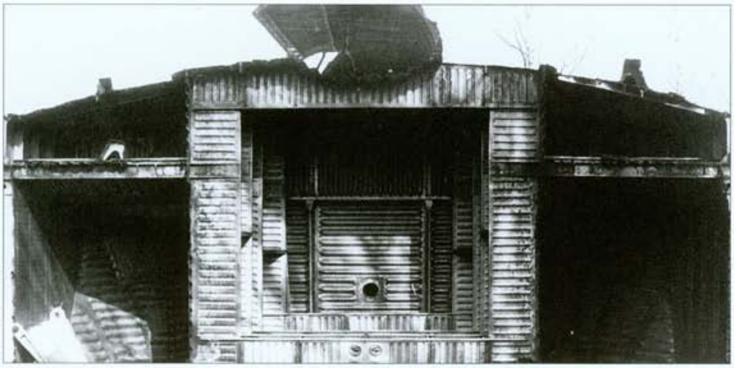
Wings

Cantilever shoulder-mounted wings of trapezoidal planform with small leading-edge root extensions (LERXes). Leading-edge sweep 41°02' on most of the span and 70°30' on the LERXes; aspect ratio 2.93, taper 3.14, incidence 0°, anhedral 5°. Wing span 13.456 m (44 ft 1$^{3}/_{4}$ in); total wing area (including centre section but excluding LERXes) 61.6 m^2 (662.36 sq ft), the detachable wing panels accounting for 41.0 m^2 (440.86 sq ft).

The wings are one-piece three-spar structures featuring camber and thin airfoils with a sharp leading edge – TsAGI P44M at the roots and TsAGI P101M further outboard. Thickness-to-chord ratio is 3.7% at the roots, 4.1 % at mid-span and 4.48% at the tips.

The wings are fitted with four-section leading-edge flaps (deflected 13°), two-section flaps 2.682 m (8 ft 9$^{19}/_{32}$ in) long (max deflection 30°) and two-section flaperons 1.7 m (5 ft 6$^{59}/_{64}$ in) long (maximum deflection ±20°). The flaperons may droop 5° in which case they are deflected 15° up and 25° down. Total flap area is 5.8 m^2 (62.36 sq ft).

The wings are attached to the fuselage by six fixtures each; each wing incorporates two integral fuel tanks The wing spars, stringers, ribs and skins are made of VNS-2 and VNS-5 high-strength stainless steel and OT4-1 and VT-20 titanium sheet. Besides the three spars, the front false spar and rear stringer are the main longitudinal structural elements. The trailing edges of the flaps and flaperons have a



Victor Drushlyakov

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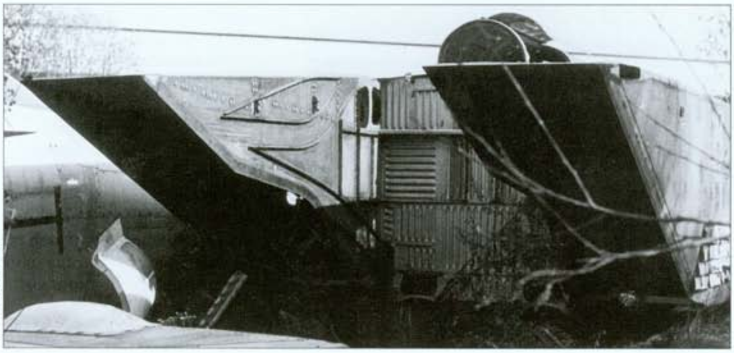
A hangar? A shed? No sir! These are the sad remains of a MiG-31 which was scrapped after running out of service life. More precisely, this is the centre fuselage section seen from the rear. In the middle is one of the integral fuel tanks. The walls and other structural members feature stiffening ribs; note the fuel line at the bottom of the inter-tank bulkhead and the hollow fuselage spine on top. The 'tunnels' on both sides used to accommodate the engines' inlet ducts.



Victor Drushlyakov

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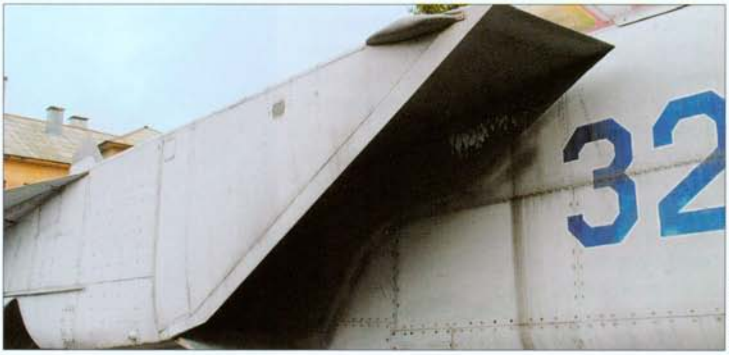
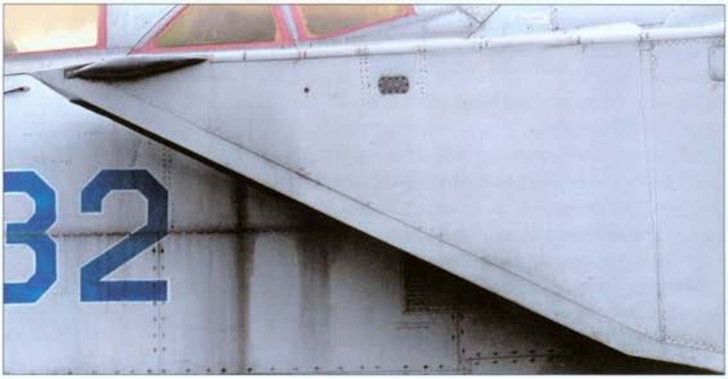
Another view of the same hulk shows the air intakes. The insides of the air intakes' inner faces (with Vee-shaped fairings connecting them to the forward fuselage sides) and the front wall of the No.1 fuselage fuel tank are never seen unless the aircraft is 'beheaded' like this.



Yefim Gordon

►

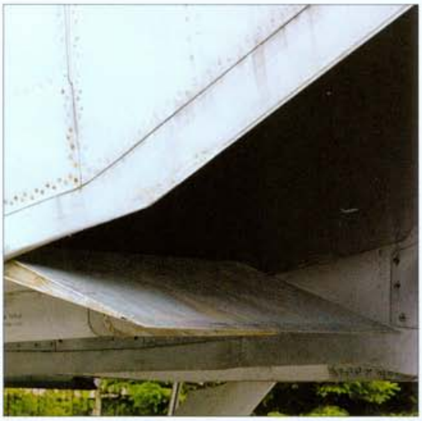
The starboard air intake of the MiG-31. The straight edge of the outer face makes an interesting contrast with the complex curvature of the inner face.



Yefim Gordon

►

This view of the port air intake illustrates well the sharply raked outer face. Note the ECM antenna fairing near the leading edge.



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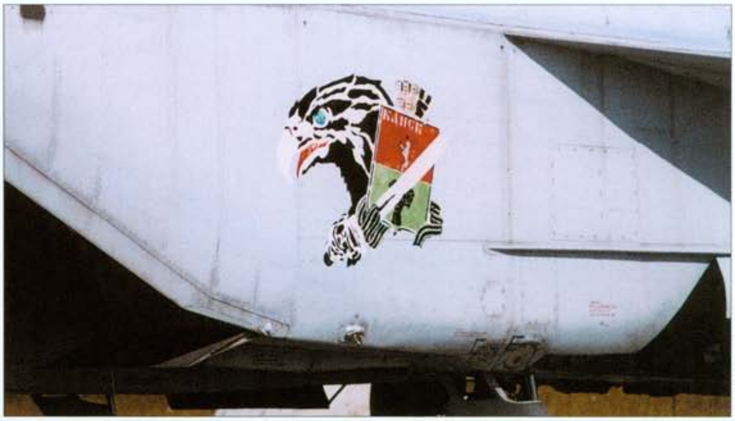
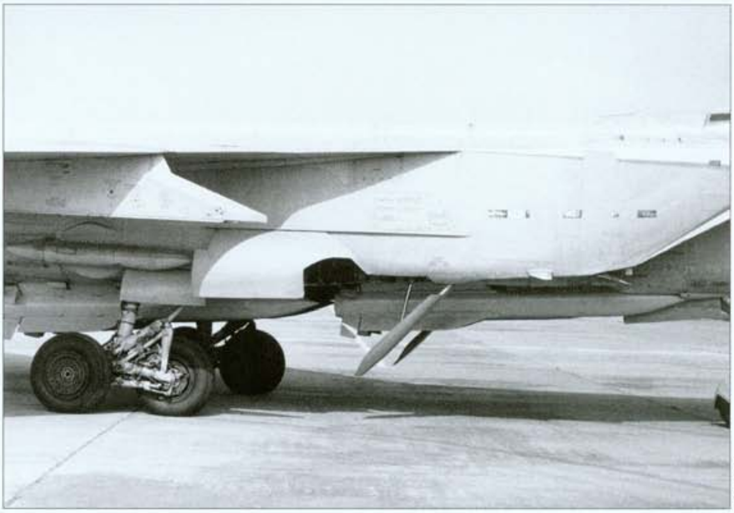


Vyacheslav martyniuk

▲ ▶

The lower lips of the air intakes deflect downwards on the ground and in low-speed flight to maximise the airflow.



RSK MiG

The centre fuselage and main landing gear units. Note the cannon fairing just aft of the starboard main gear unit.

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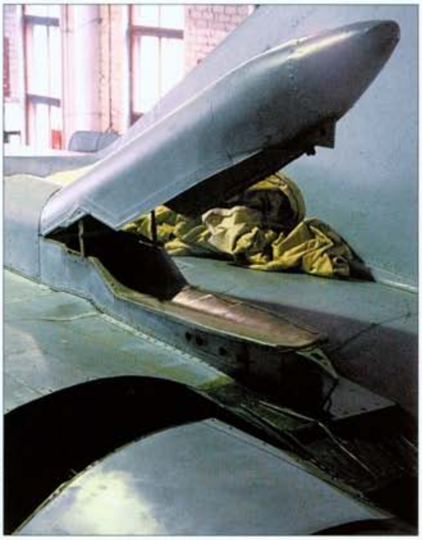
The open brake parachute housing of a production MiG-31. The housing forms the rear extremity of the fuselage spine.

▼



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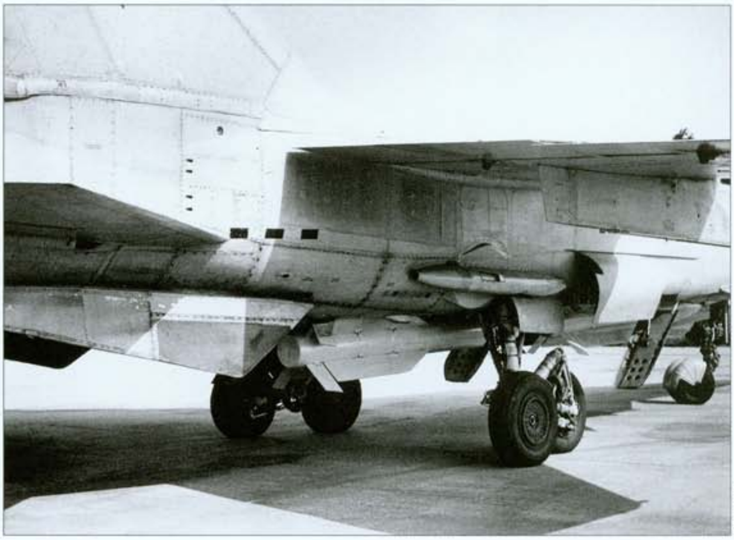
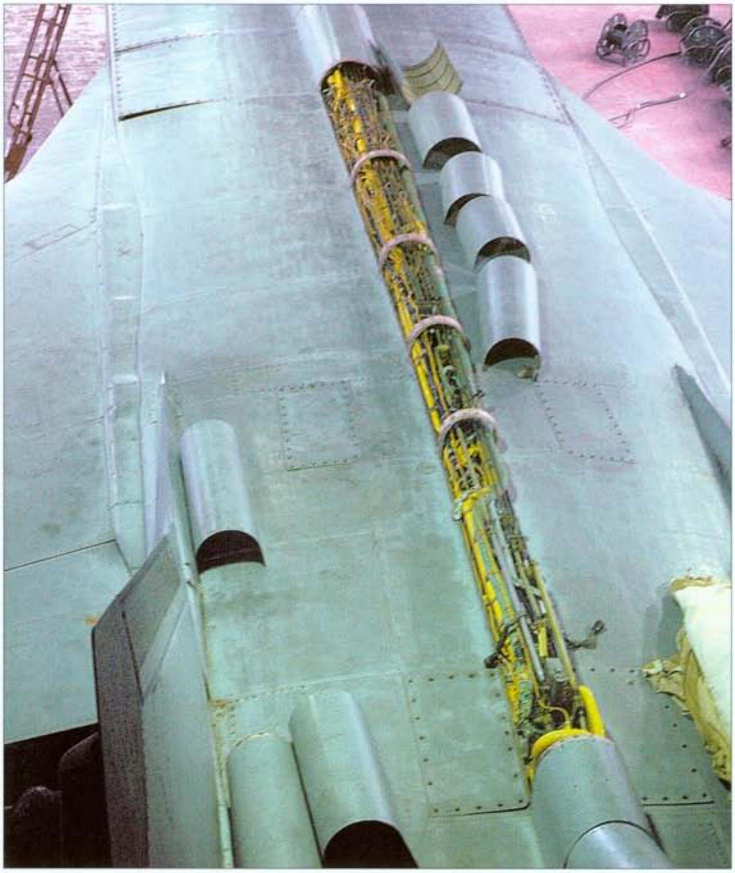


RSK MiG

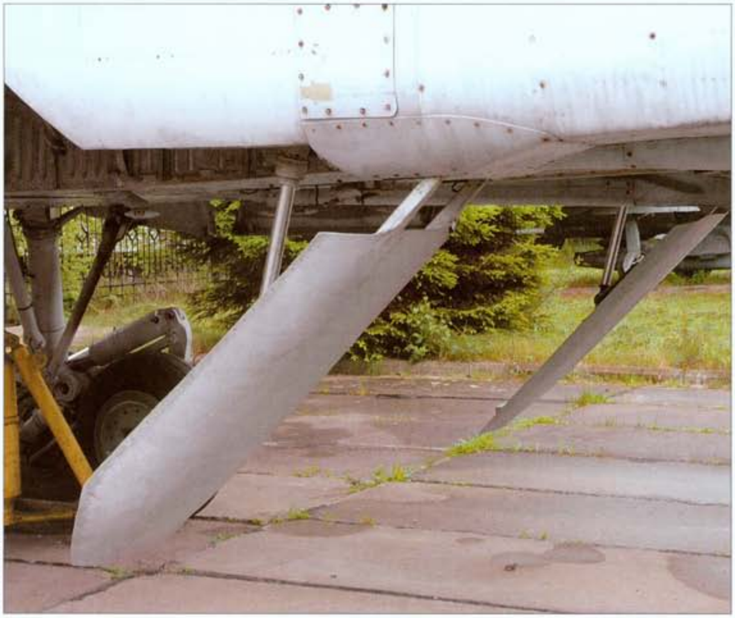


Yefim Gordon

◄
Upper view of the centre fuselage. The covers forming the fuselage spine have been removed for maintenance, revealing the wiring and the yellow fuel lines housed inside. Note the angular wing/fuselage fairings.

▼◄
The forward doors of the mainwheel wells double as airbrakes. All landing gear doors remain open when the gear is down.

Rear view of the port forward main gear door/airbrake. Note the weight-saving holes in the inner skin of the door.
▼



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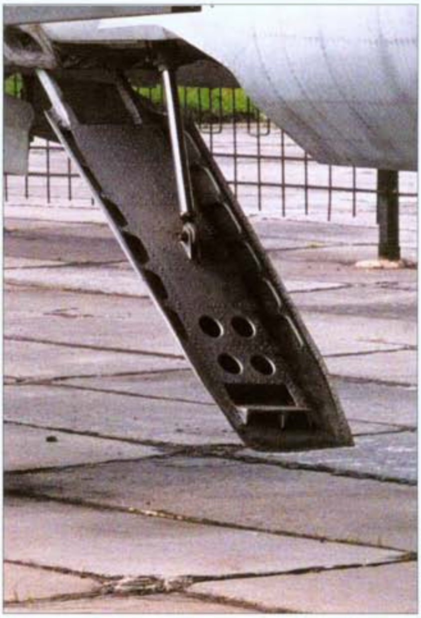

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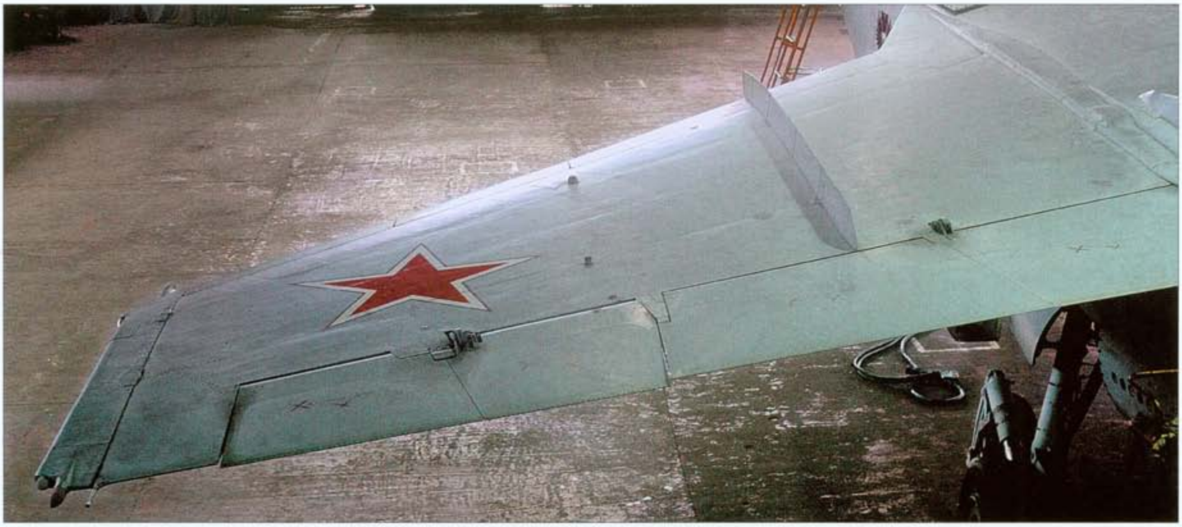

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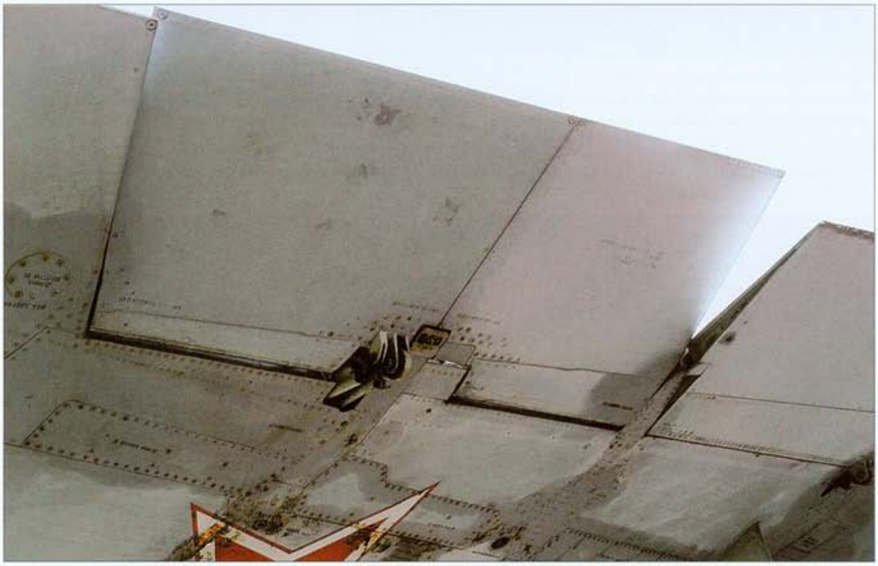
▲
The port wing panel, showing the boundary layer fence and the wingtip-mounted RHAWS antenna. Note that the aileron terminates some way short of the wingtip.

▶
The port aileron seen from below. The ailerons are manufactured in two independently actuated sections which move in concert; the push-pull rods of the outboard sections are located below, while those of the inboard sections are located above.

The undersurface of the starboard wing. Note that the flaps are also built in two sections.
▼



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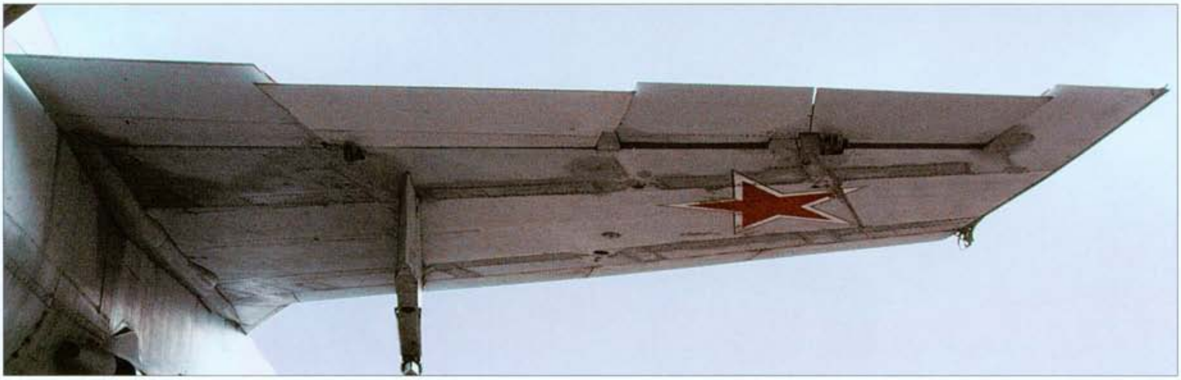

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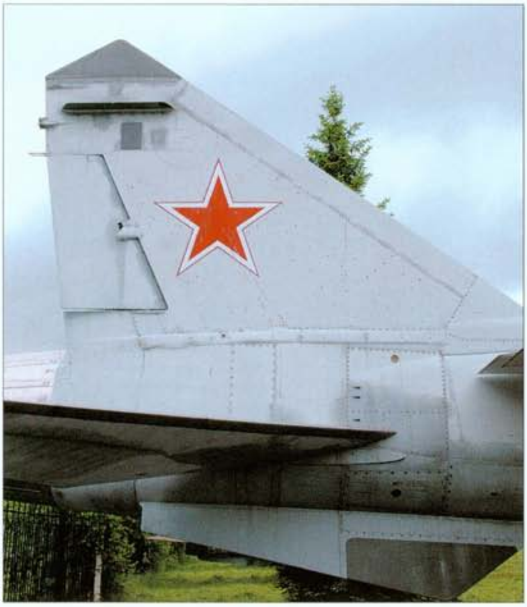

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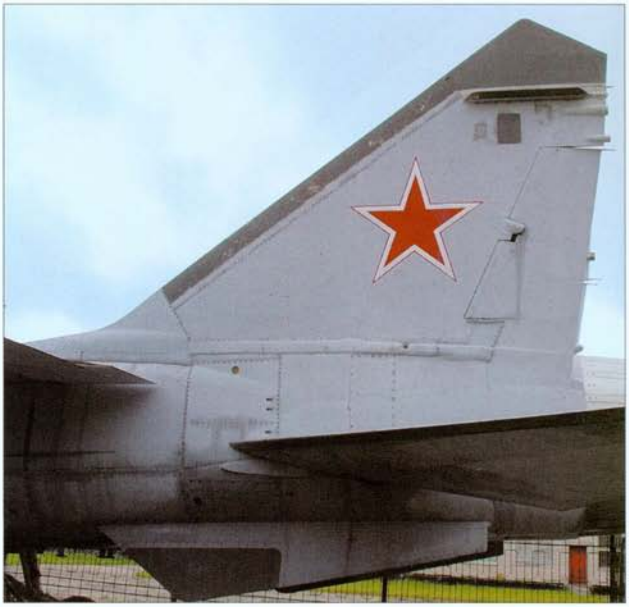
▲
The starboard vertical tail; the dielectric fin cap conceals an antenna, and a strake aerial is installed below.



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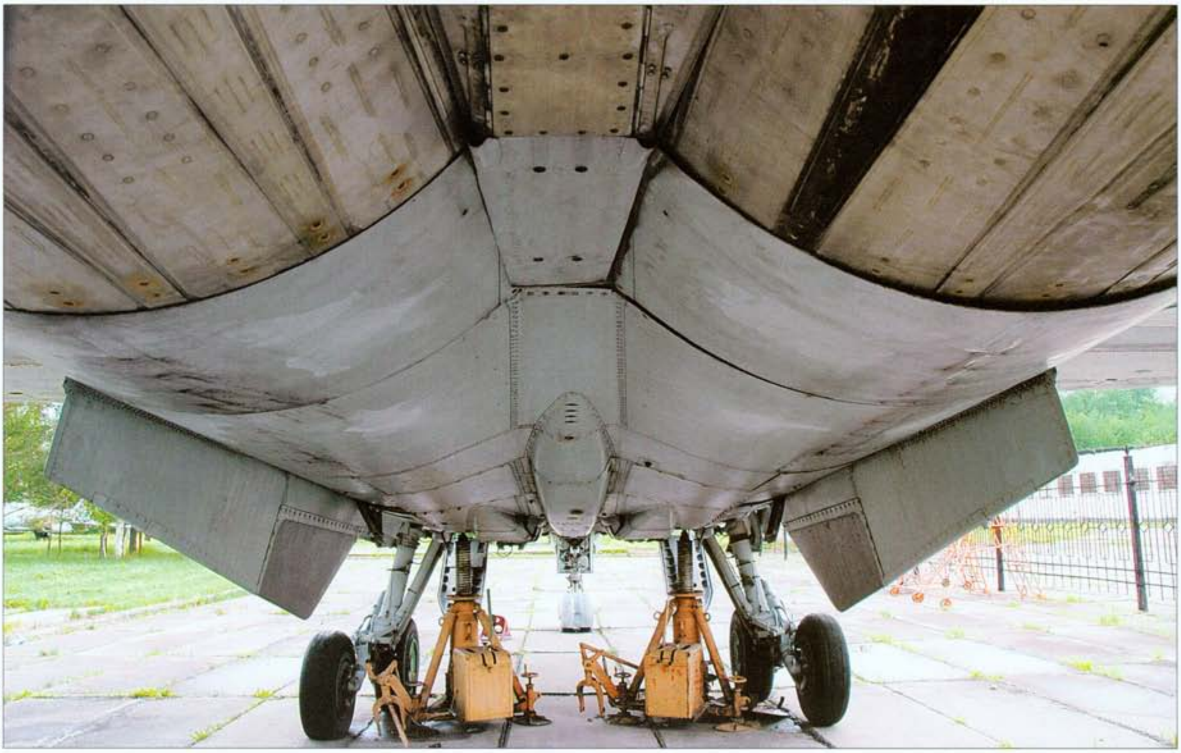
▲
The port vertical tail. Note that the dielectric fin cap is larger on the port fin and the leading edge is also dielectric, accommodating an additional antenna.

The rear fuselage underside. The aircraft is jacked up for a wheel change. The canted ventral fins with dielectric forward portions are easily seen.
▼



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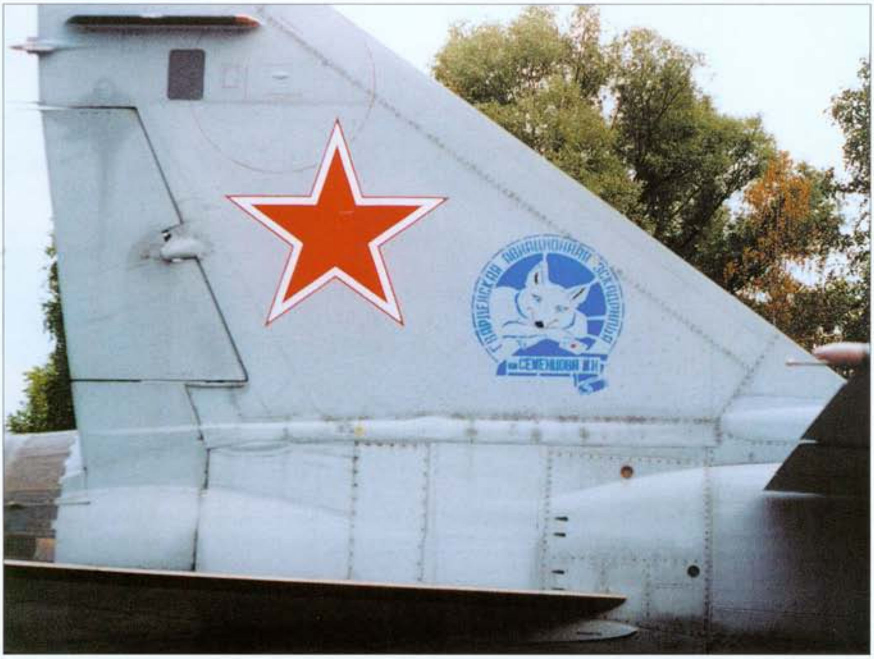
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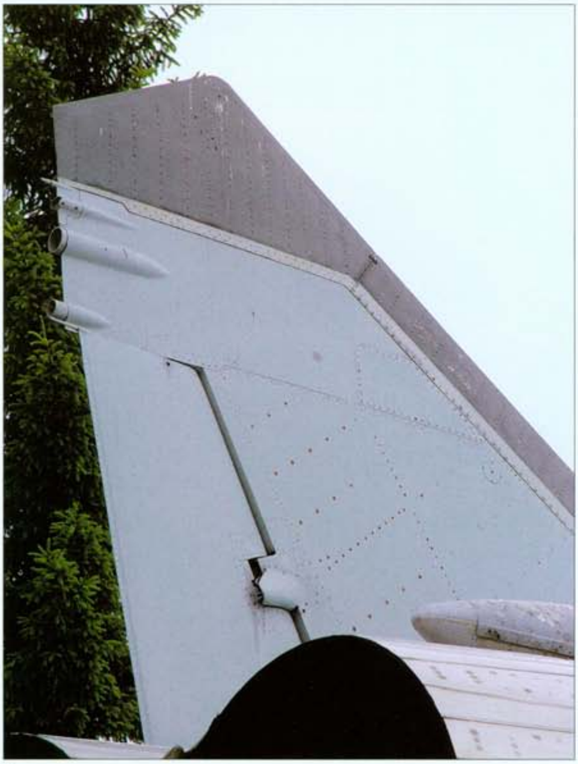
РУСАВИА
Yefim Gordon

◄ ▲
The MiG-31's fins sometimes served as 'billboards', as illustrated by these examples at Savasleyka. Left: the badge of a Guards air squadron named after M. I. Sementsov (a fox with an ace of diamonds); right: the logo of the Rusavia publishing house. These views show well the fin-to-fuselage joint.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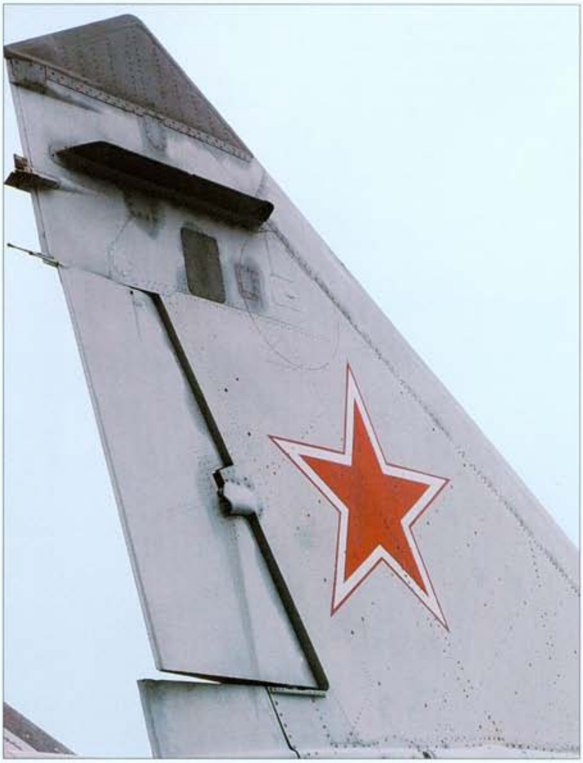
▲
The inboard face of the port fin; the navigation light has been removed.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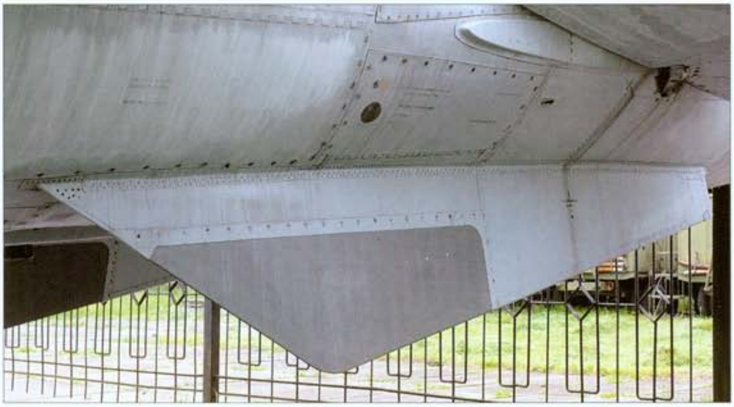
▲
The outer face of the starboard fin, showing the assorted aerials.



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▲
The port stabilator/fuselage joint and ventral fin.

▶▶
Top left: The starboard main landing gear unit, showing the bogie frame, the jury strut inboard of the oleo leg, the ventrally positioned rocking damper and the relative position of the wheels. The front wheels are positioned inboard so as not to hamper the bogie's rotation during retraction, a measure that allows the bogies to stow in the smallest possible space.

Centre left: The main gear oleos are canted outwards and inclined aft when extended. Each mainwheel well is closed by three doors.

Bottom left: This view shows the bogie rotation jack on top of the bogie, the brake mechanism inside the front wheel, the cooling vents in the rear wheel and the cannon fairing with blast gas vents.

Top, centre and below right: Typically of Soviet combat aircraft, the nose gear unit features a large mud/snow/slush guard for wet season (and possibly soft-field) operations. The forward nose gear door segment incorporates two landing lights and a taxi light. Note the aft-mounted breaker strut and the cylinders of the steering mechanism/shimmy damper on the oleo strut.

bonded honeycomb structure; the LE flaps have a riveted structure. Each wing has two attachment points for a missile pylon and two more for a 'wet' pylon designed for carrying a drop tank (and also 'dogfight missiles').

Tail Unit

Cantilever twin-fin tail unit. The low-mounted horizontal tail consists of slab stabilisers (stabilators) of riveted construction. Leading edge sweep 5°22', anhedral 1°25', span 8.75 m (28 ft 8½ in), area 9.82 m^2 (105.59 sq ft) The leading edges are covered with titanium skin and are left unpainted.

The twin vertical tails consist of fins with inset rudders. They are canted outboard 8° and have a total area of 15.6 m^2 (167.9 sq ft); leading-edge sweep is 54°. The vertical tails have a riveted structure and are identical, except for the leading edges and tip fairings. The spar box of each fin doubles as an integral fuel tank. The rudders are attached to the fins on three hinges each. The detachable fin tip fairings are made of glassfibre/Textolite composite and enclose antennas. The leading edge fairings are also detachable; the port fin leading edge is riveted from D19 duralumin while the starboard fin leading edge is made of Textolite.

Two ventral fins canted outboard 12° are attached to fuselage frames 12-14. They are likewise of riveted structure and have dielectric forward sections.

The port stabilator of a MiG-31 undergoing refurbishment; the structure is coated with primer, hence the odd green colour. The unpainted leading edge sheath made of heat-resistant steel is clearly visible.
▼

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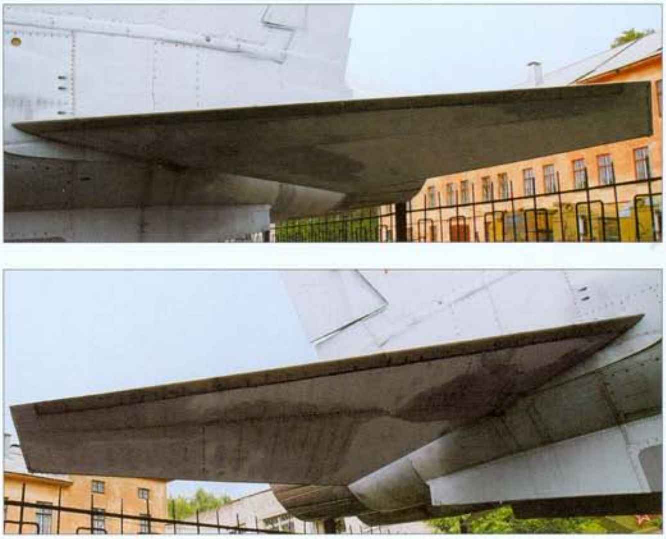
The port and starboard stabilators; the raked tips are thus profiled to increase the tailplane's resistance to flutter.
▼ ▶



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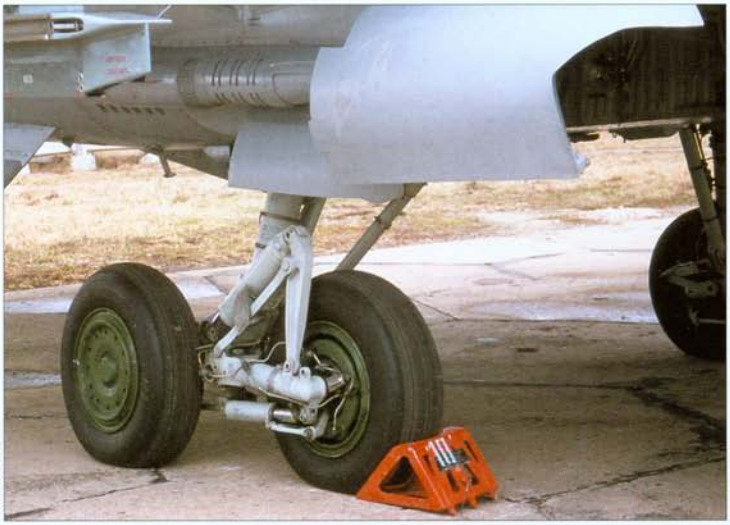

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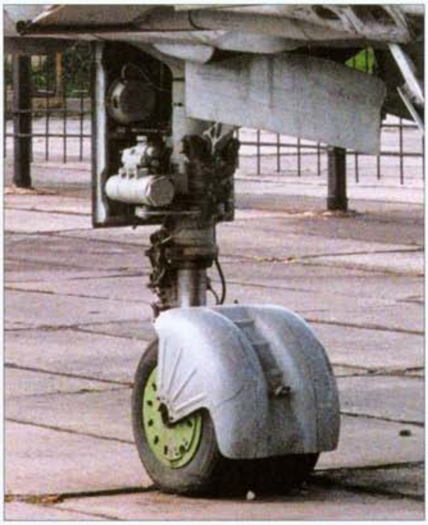

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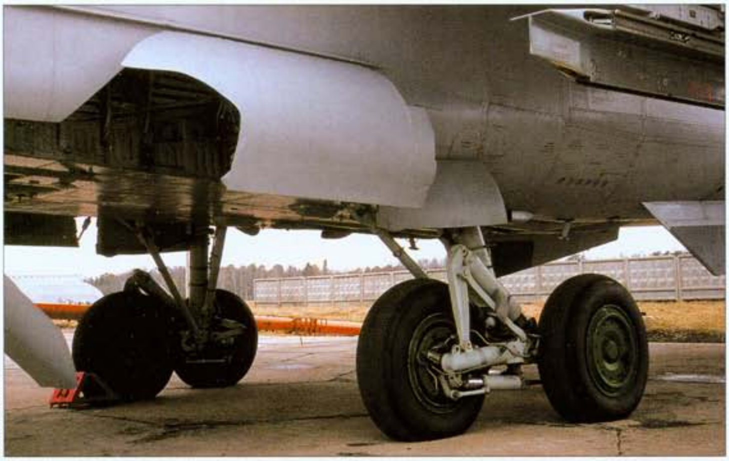

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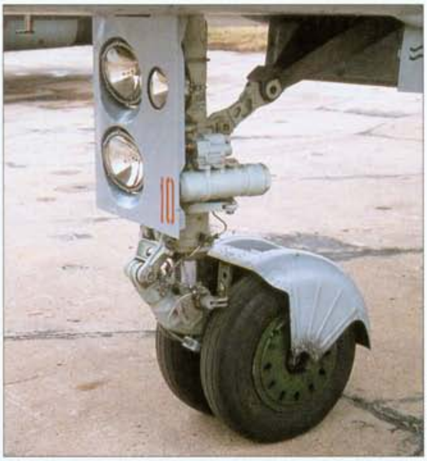

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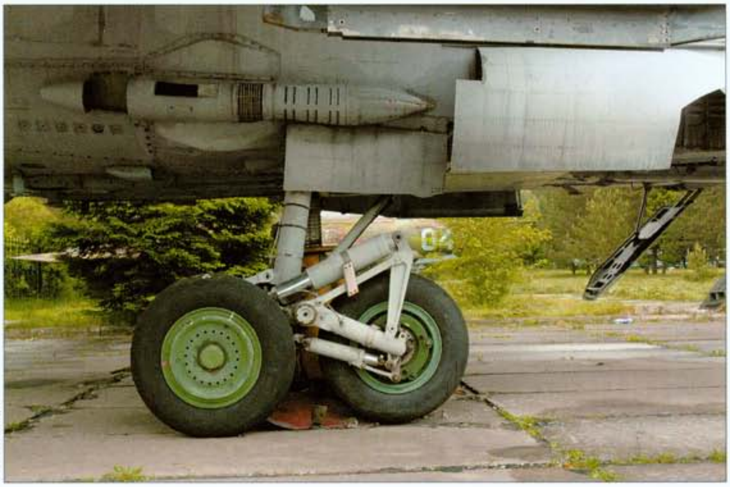

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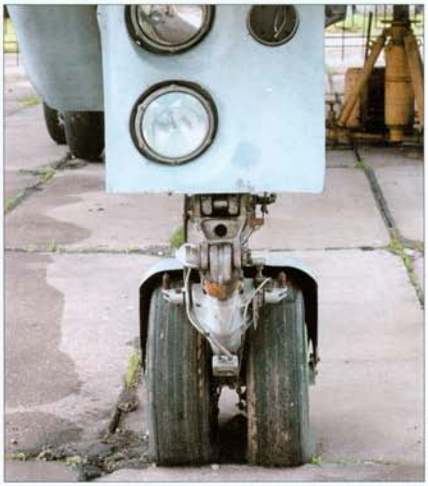

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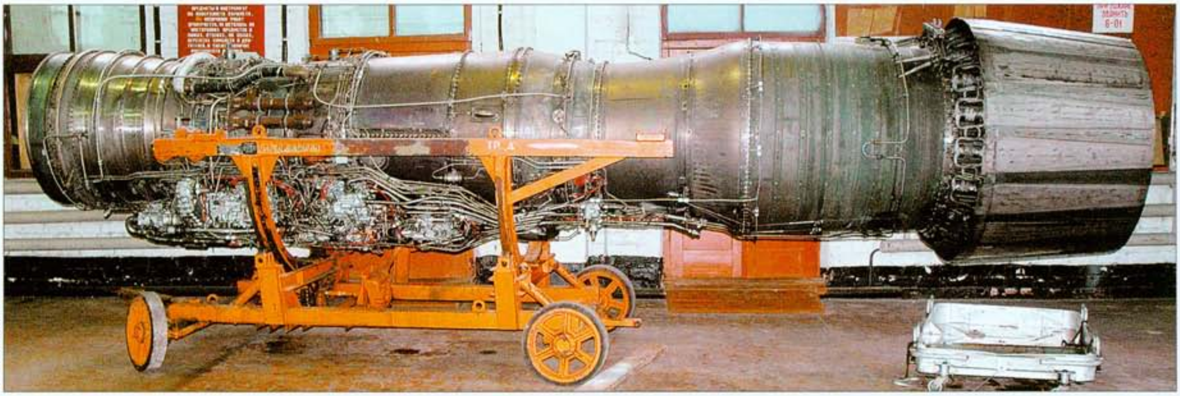
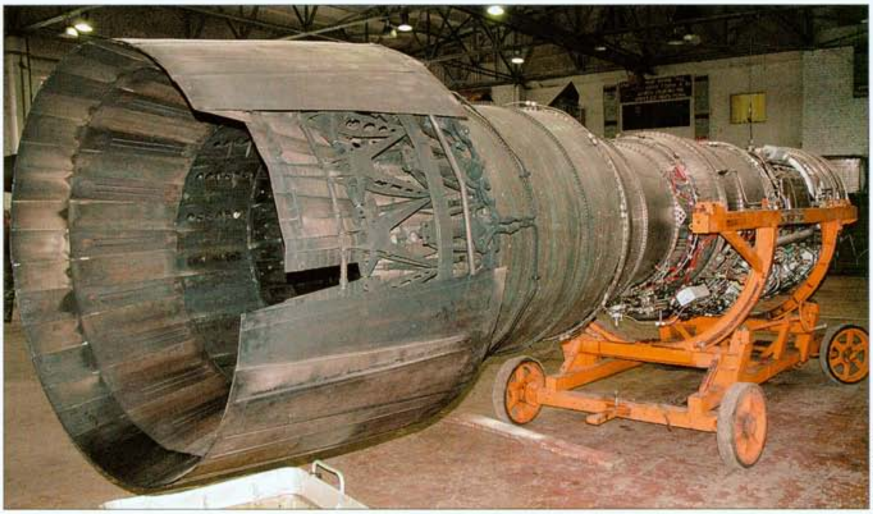


Yefim Gordon

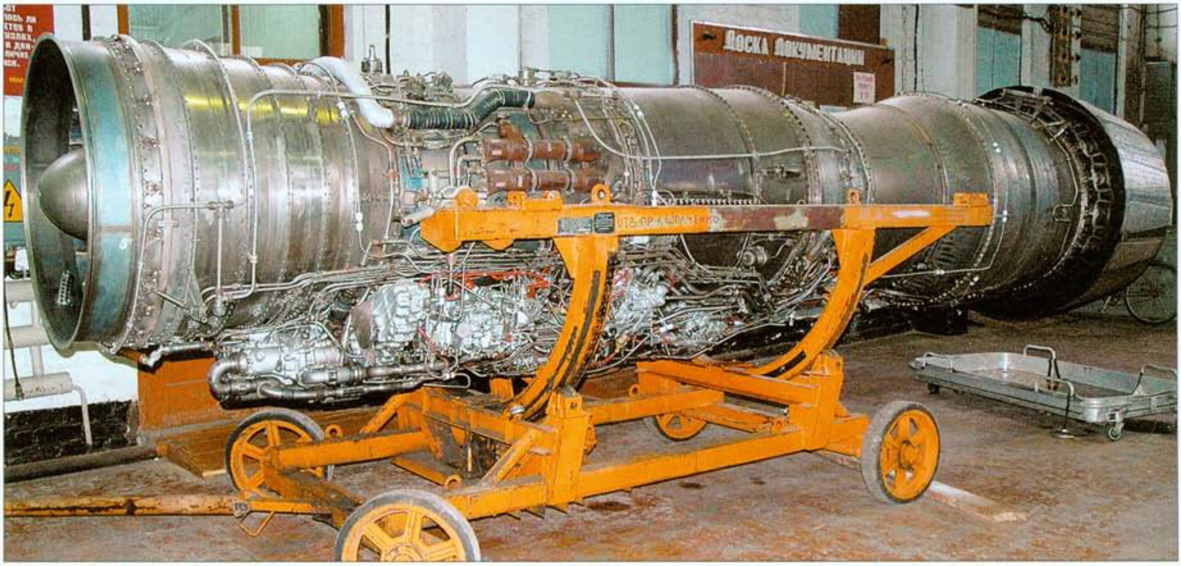
▲ A Solov'yov D30F-6S afterburning turbofan on a transport dolly at a maintenance shop. This view shows well the long afterburner casing; a pan on wheels is placed under the nozzle to capture any oil dripping from the afterburner assembly.



Yefim Gordon

► The axisymmetrical convergent-divergent nozzle of the D30F-6S. Several nozzle petals are missing (as they should be – see opposite page!), revealing the inner row of petals.

Three-quarters front view of the D30F-6S, showing the ventrally located accessory gearbox and the fixed air intake spinner. ▼



Yefim Gordon

Landing Gear

Hydraulically retractable tricycle type; wheel track 3.638 m (11 ft 11$^{7}/_{32}$ in), wheelbase 7.113 m (23 ft 4 in). The levered-suspension aft-retracting nose unit is equipped with twin 660 x 200 mm (25.98 x 7.87 in) KT 176 wheels and a mud/snow/slush guard. The forward-retracting main units have twin-wheel bogies with 950 x 300 mm (37.54 x 11.81 in) KT-175 wheels in a staggered-tandem arrangement (front wheel inboard, rear wheel outboard). During retraction the bogies rotate nose-up around the oleos to lie inverted in a horizontal position under the engines' inlet ducts. All units are equipped with oleo-pneumatic shock absorbers and all wheels are fitted with brakes.

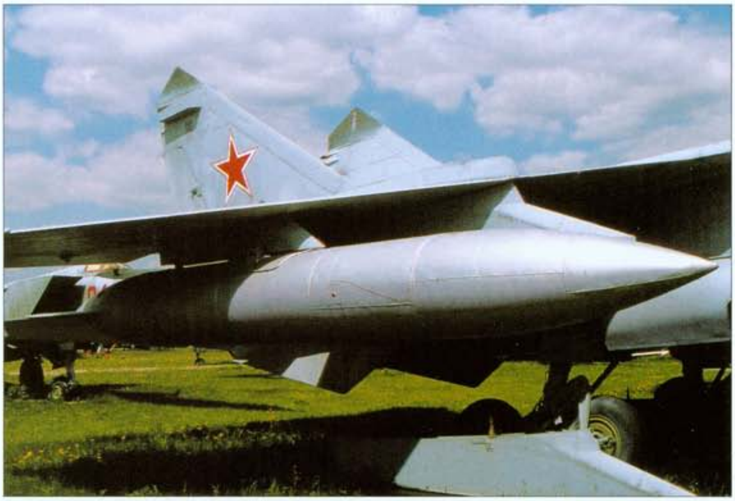
The nosewheel well is closed by a forward door segment linked to the oleo (and incorporating landing and taxi lights) and two lateral door segments. Each mainwheel well is closed by a forward-hinged panel, which opens only while the gear is in transit, a main door and a small rear door segment (both outward-opening). The forward mainwheel well doors double as airbrakes with a total area of 1.39 m^2 (14.9 sq ft) which can be deflected 39°.

In addition to the wheel brakes, two cruciform parachutes with a total area of 50 m^2 (537.6 sq ft) are provided to shorten the landing run; these are extracted by two drag chutes each with an area of 0.05 and 1.5 m^2 (0.53 and 16.12 sq ft) respectively. The brake parachute container is located dorsally between the engine nozzles and opens upwards.

Powerplant

Two Solov'yov D30F-6S afterburning turbofans (often referred to in paperwork as D30F-6 or *izdeliye* 48) rated at 9,140-9,270 kgp (20,400-20,690 lbst) at full military power and 14,965-15,510 kgp (33,400-34,620 lbst) in full afterburner. The MiG-31M is powered by uprated D30F-6M engines.

The D30F-6S is a two-spool turbofan with a fixed-area subsonic air intake, a five-stage axial low-pressure (LP) compressor, a ten-stage axial high-pressure (HP) compressor, a can-annular combustion chamber with 12 flame tubes, two-stage axial HP and LP turbines (the former has air-cooled blades), an afterburner and a convergent-divergent axisymmetrical supersonic nozzle. The afterburner features a core/bypass flow mixer and a ring-type flame holder. The nozzle is fully adjustable, with active control of the subsonic



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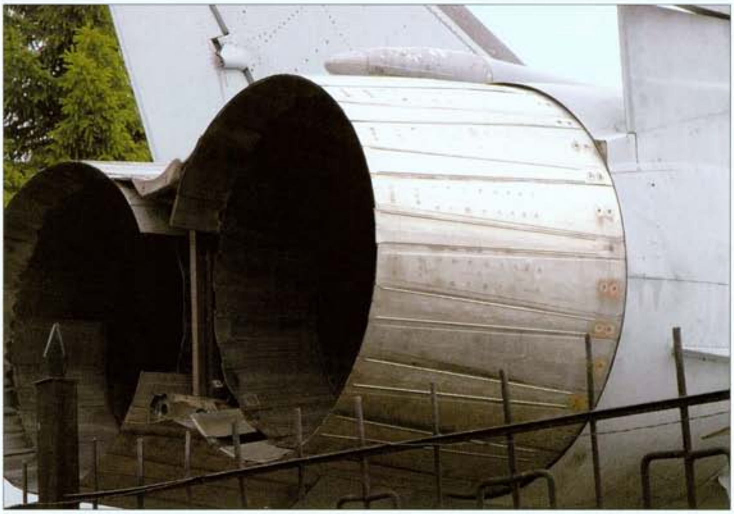

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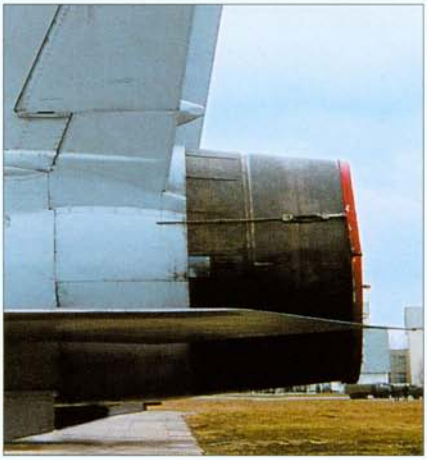


▲▲
A 2,500-litre (550 Imp gal) auxiliary fuel tank under the port wing of a MiG-31. Such tanks are fitted for ferry flights only.

▲
As this view shows, the MiG-31's engines are placed so close that the nozzles overlap, requiring several outer petals on each engine to be removed and special fairings to be fitted above and below the gap.

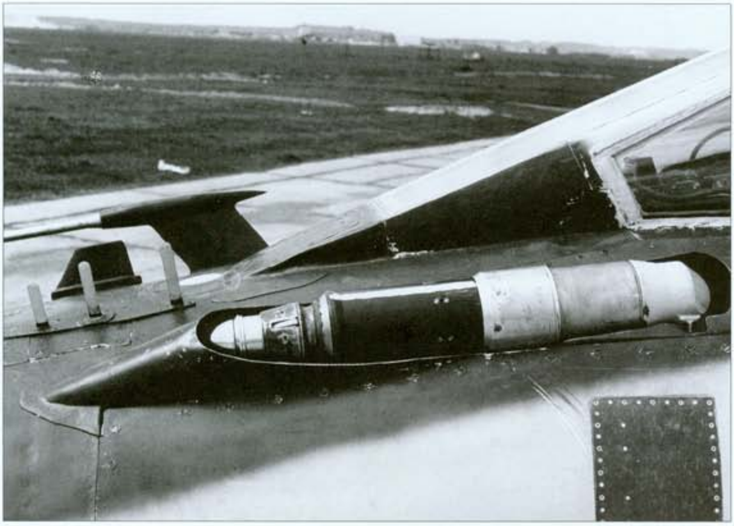
◄
The MiG-31M is powered by uprated D30F-6M engines which can be identified by the 'solid' outer nozzle shroud with no visible petals.

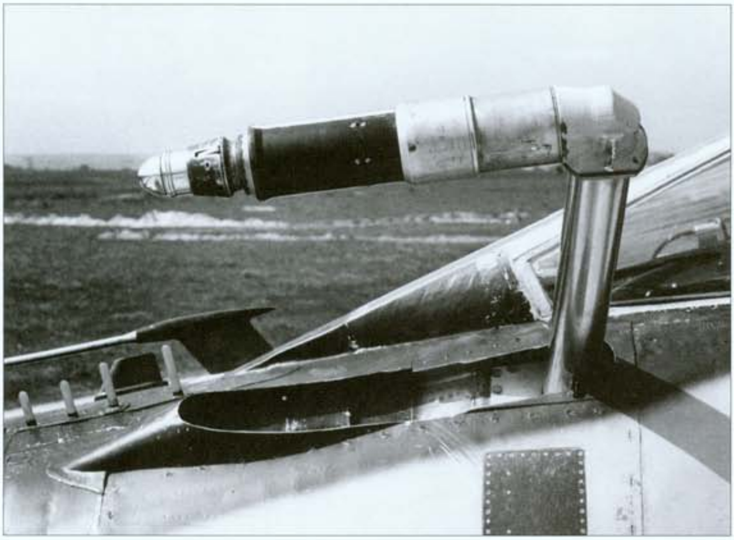
flow petals by means of 18 hydraulic rams and aerodynamic control of the supersonic flow petals. The divergent part of the nozzle incorporates special suction relief valves admitting outside air to eliminate exhaust gas flow pulsations.

Bypass ratio 0.55 in dry mode or 0.52 in reheat mode, overall engine pressure ratio at sea level 7.05, maximum turbine temperature 1,660°K; specific fuel consumption 0 72 kg/kgp·hr (lb/lbst·hr) in dry mode or 1.9 kg/kgp·hr in reheat mode. Engine dry weight is 2 416 kg (5,326 lb).

Control System

Mechanical flight control system, with hydraulic actuators throughout. The MiG-31 *sans suffixe* (*izdeliye* 01 and *izdeliye* 01DZ), MiG-31B and MiG-31BS have dual controls allowing the WSO to fly and land the aircraft; this feature is eliminated on the MiG-31M.


RSK MiG

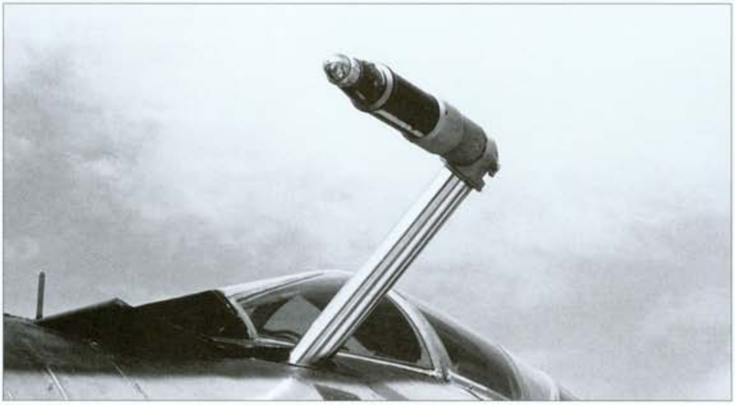

RSK MiG

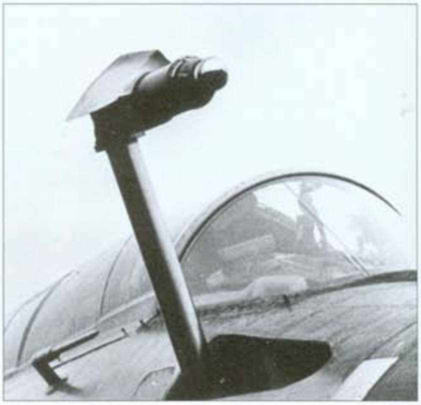
▲◄
The stowed IFR probe on MiG-31 '77 Red', the first probe-equipped example.

◄
The IFR probe of '77 Red' in deployed position; the tip is angled slightly downward because it has to be that way to fit inside the forward fuselage contour. Note the fairing around the probe.

▼◄
Another view of the deployed refuelling probe as fitted to the MiG-31 (*izdeliye* 01DZ) and MiG-31B.

The deployed IFR probe of MiG-31M '057 Blue'. The MiG-31M has a different probe which is offset to starboard, not to port, and stows completely inside the fatter nose, hence the door attached to the probe.
▼


RSK MiG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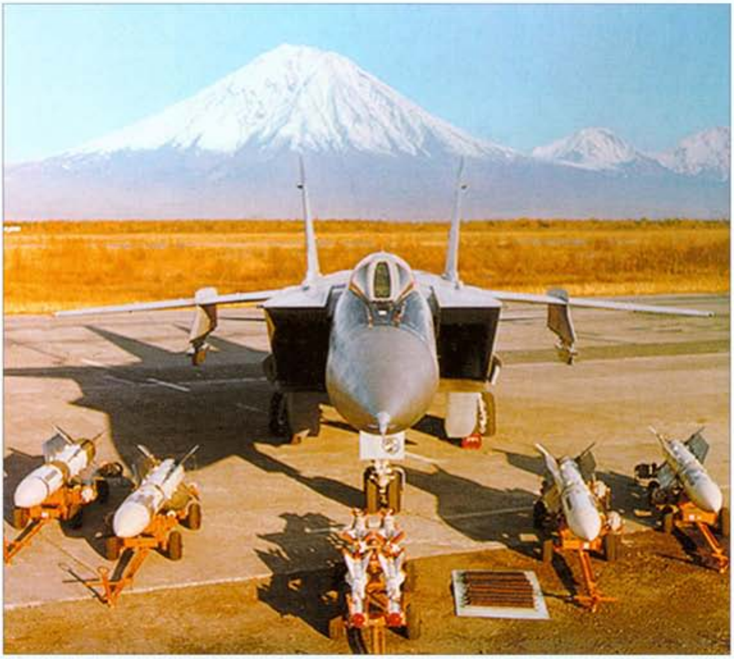
Fuel System

Fuel is carried in seven integral tanks in the fuselage, four more in the wings and two more in the fins; total internal fuel capacity is 18,500 litres (4,070 Imp gal). Two 2,500-litre (550 Imp gal) drop tanks can be carried on the inboard wing pylons, increasing the total capacity to 23,500 litres (5,170 Imp gal). Normally the aircraft carries 13,700 litres (3,014 Imp gal) of fuel in the Nos 2-5 fuselage tanks, the wing tanks and half-filled drop tanks. Minimum mission fuel is contained in the Nos 3 and 4 fuselage tanks and the wings.

The Nos 1 and 2 fuselage tanks occupy the space between frames 4 and 6; the No.3 tank is located between frames 6-7, the Nos 4 and 5 tanks between frames 7-11 and the Nos 6 and 7 tanks between frames 11 and 12B. A coolant tank adjacent to the No.7 fuel tank is located between frames 12-13.

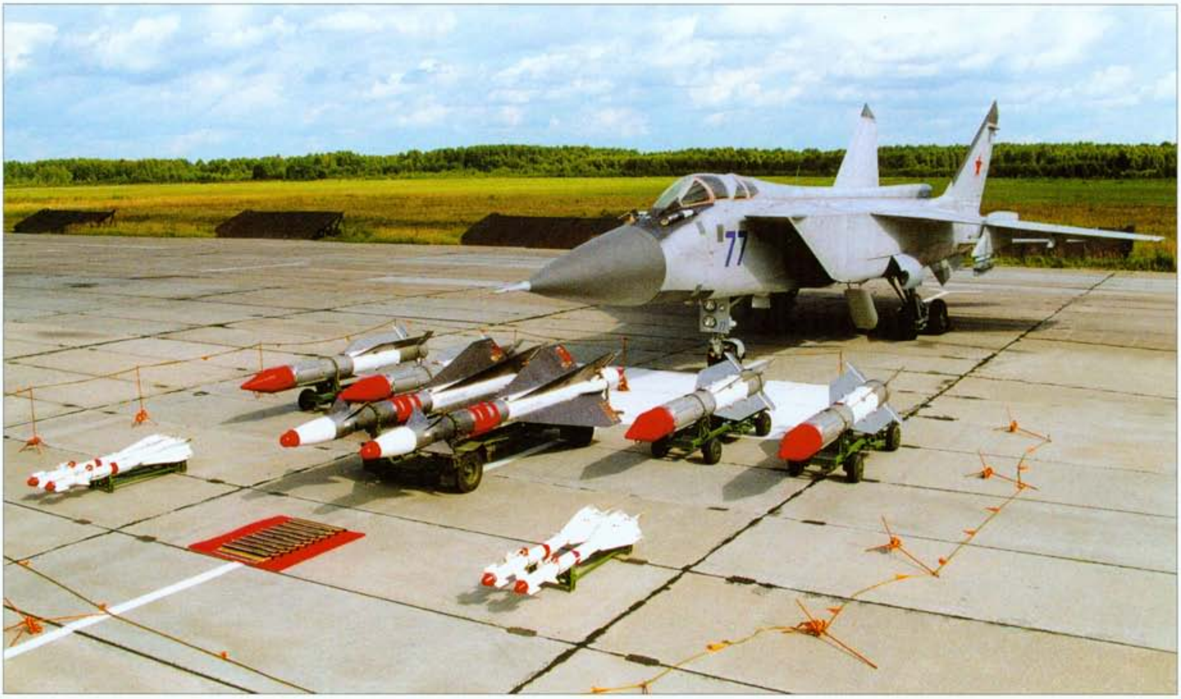
Armament

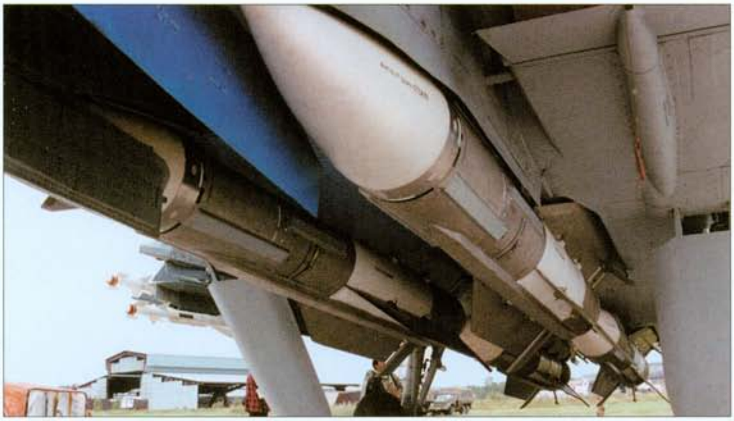
The main weapons option of the MiG-31 *sans suffixe* (*izdeliye* 01 and *izdeliye* 01DZ) comprises four R-33 long-range air-to-air missiles carried in tandem pairs semi-recessed in the fuselage underside on AKU-410 pantographic ejector racks. The R-33 has semi-active radar homing (SARH), a launch weight of 480 kg (1,060 lb), including a 47-kg (103-lb) high-


Sergey Skrynnikov

▲ **The MiG-31's most common weapons complement is four R-33 long-range AAMs under the fuselage and four R-60M short-range AAMs on twin APU-60-2 racks under the wings.**

The armament of the MiG-31B: four R-33s, four R-60Ms, two R-40TDs and cannon ammo. ▼


Vyacheslav martyniuk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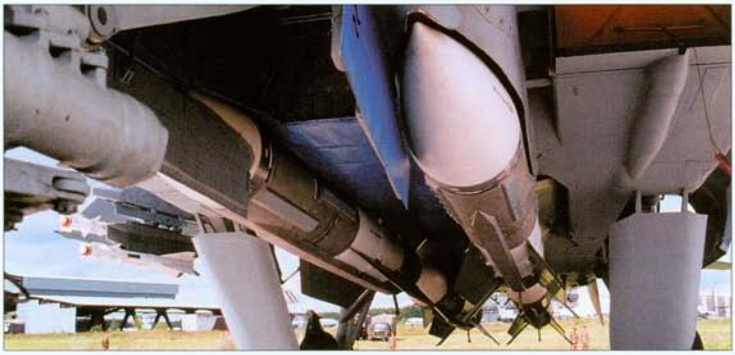
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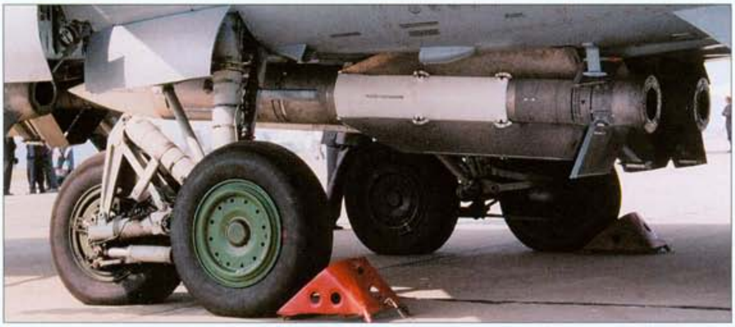
◄▼
The R-33 long-range AAMs are carried under the fuselage, and the forward pair is... well, more semi-recessed than the rear one. Note the special cut-outs near the air intakes for the missile's fins.

The rear pair of R-33s is set lower and is, in fact, almost completely exposed. Note the folded upper pair of rudders.
▼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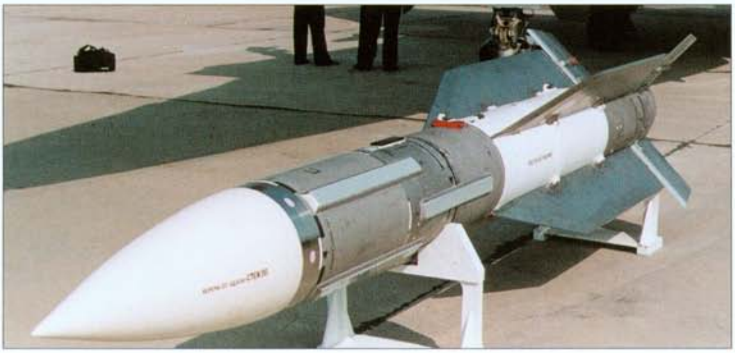
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◄
The R-33 is quite a large weapon. This view shows the large ogival radome of the semi-active radar seeker head, the flush transmitter and receiver aerials of the radar proximity fuse aft of it (three on each side), the long, low aspect ratio fins and the aft-mounted rudders of greater span. Only the upper pair of rudders has the folding feature.

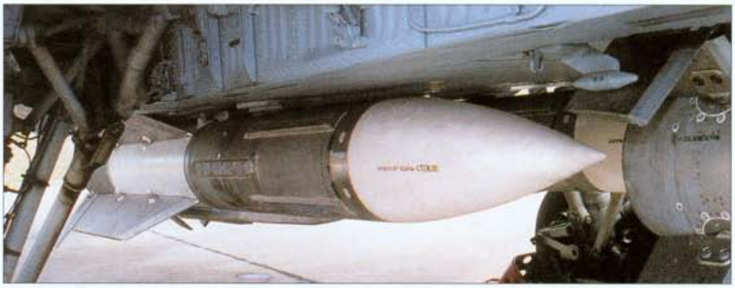
explosive/fragmentation warhead, and a range of 120 km (74.5 miles).

Alternative weapons fits are three R-33 missiles in fuselage bays and two R-40TD (or R-40T) medium-range IR-homing AAMs carried on underwing pylons (the fourth R-33 is replaced by an APP-46TD guidance system pod for the R-40s); or four R-33s and two or four R-60M short-range IR-homing AAMs on underwing pylons on single APU-60-1 or double APU-60-2 launch rails.

The R-33 long-range AAM was designed for multi-channel guidance and tailored for a fighter equipped with a phased-array radar which is capable of guiding SARH missiles to several targets at once. In the event of a multiple-target attack each missile is guided in intermittent mode, as the radar illuminates the targets consecutively and part of the operating time is spent on scanning the airspace for possible new targets.

The R-33's semi-active radar seeker head features a processor which predicts the angle speed of the target viewing line. The processor receives inputs on the initial target range, closing speed and the angle speed of the target viewing line before launch. A peculiarity of the R-33's seeker head processor is that it comes into play after the stabilisation system has neutralised the post-launch oscillations. Therefore the missile must reach a predesignated point before the processor is activated, and target range, closing speed and the angle speed of the target viewing line two seconds after the launch are computed on board the fighter.

The R-33's radar seeker head makes use of a gyroscopic stabilisation system utilising angle speed sensors. Target lock-on can be achieved after the missile has covered one-



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Another view of the rear pair of R-33 AAMs under the MiG-31's belly. The stencil on the radome says 'Fragile – glass'; actually it is fibreglass, of course.

third of the trajectory. This ability is due partly to the accurate assessment of the angle speed of the target viewing line exhibited by the interceptor's radar (the error margin is 0.01-0.03 deg/sec).

The Doppler seeker head is characterised by the strict correlation of its functioning with the target illumination periods which equal 20 milliseconds. Target search is performed within this time frame; until the next target illumination period the seeker head is locked for incoming signals and the signals generated by it are computed on the basis of the preceding measurements. Lock-on range for a medium bomber-sized target (such as a Tu-16) is about 90 km (56 miles); together with the inertial guidance phase this makes for a maximum launch range of 120-130 km (74.5-80.75 miles).

The R-33 has a normal aerodynamic layout with aft-mounted rudders and a conventional airframe design; the layout and aerodynamics were influenced by the need to enable semi-recessed carriage.

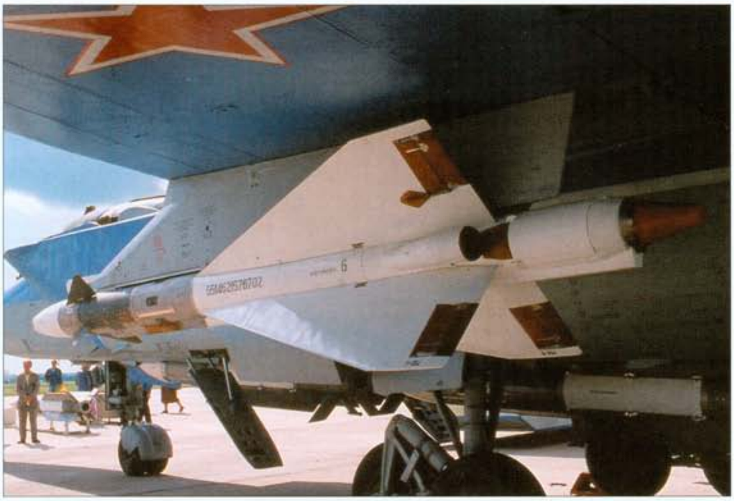
Main Specifications of the R-60M

Aerodynamic layout	Tail-first, with canards and rollerons
Overall weight, kg (lb)	44 (97)
Warhead weight, kg (lb)	3.5 (7.7)
Body diameter	0.12 m ($4^{23}/_{32}$ in)
Length	2.1 m (6 ft $10^{5}/_{8}$ in)
Stabiliser span	0.39 m (1 ft $3^{11}/_{32}$ in)
Thrust/weight ratio, kgp/kg (lbst/lb)	57
Powerplant	Single-mode solid-fuel rocket motor
Targeting algorithm	Pursuit mode targeting with ±12° target lead
Guidance system	Thermoelectrically cooled infra-red seeker head
Maximum target speed, km/h (mph)	2,500 (1,550)
Target altitude, m	30-20,000 (100-65,620)
Max launch range in pursuit mode, km (miles)	8 (5)
Min launch range in pursuit mode, km (miles)	0.25 (0.15)
Max target manoeuvring G force	8

Main Specifications of the Medium- / Long-Range AAMs Carried by the MiG-31

	R-77	**R-33**
Aerodynamic layout	Normal, with lattice wings	Normal
Overall weight, kg (lb)	177 (390)	520 (1,150)
Warhead weight, kg (lb)	21 (46)	47 (103)
Warhead type	Multiple shaped-charge	Fragmentation
Body diameter	0.20 m ($7^{7}/_{8}$ in)	0.38 m (1 ft $2^{31}/_{32}$ in)
Length	3.60 m (11 ft $9^{47}/_{64}$ in)	4.15 m (13 ft $7^{25}/_{64}$ in)
Stabiliser span	0.7 m (2 ft $3^{1}/_{2}$ in) *	1.12 m (3 ft $7^{19}/_{64}$ in)
Thrust/weight ratio, kgp/kg (lbst/lb)	79	73
Powerplant	Single-mode solid-fuel rocket motor	Dual-mode solid-fuel rocket motor
Seeker head field of view	±180°	± 60°
Guidance system	Inertial guidance with mid-course correction, switch to active radar homing for terminal guidance	Inertial guidance, switch to semi-active radar homing for terminal guidance
Maximum target speed, km/h (mph)	3,600 (2,236)	3,700 (2,300)
Target altitude, m (ft)	20-25,000 (65-82,020)	50-28,000 (164-91,860)
Maximum launch range in head-on/pursuit mode, km (miles)	60/20 (37.25/12.4)	120/40 (74.5/24.8)
Minimum launch range in pursuit mode, km (miles)	0.3 (0.18)	2.5 (1.5)
Maximum target manoeuvring G force	12	3-4

* folding stabilisers



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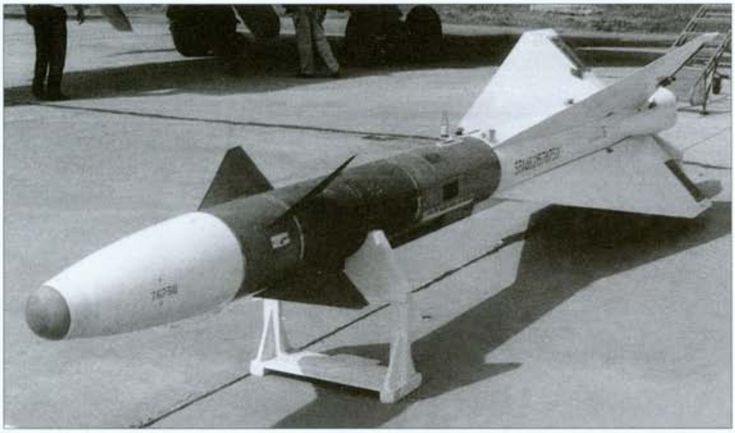
Vyacheslav Martyniuk

▲
An R-40TD on a ground handling dolly with a protective cap over the seeker head.

◄▲
An R-40TD IR-homing medium-range AAM on the port inboard wing pylon. The missile has both movable canards and inset ailerons on the fins. Note the lateral nozzles and the red protective cap over the aft-mounted aerial receiving mid-course guidance signals from the aircraft's radar.



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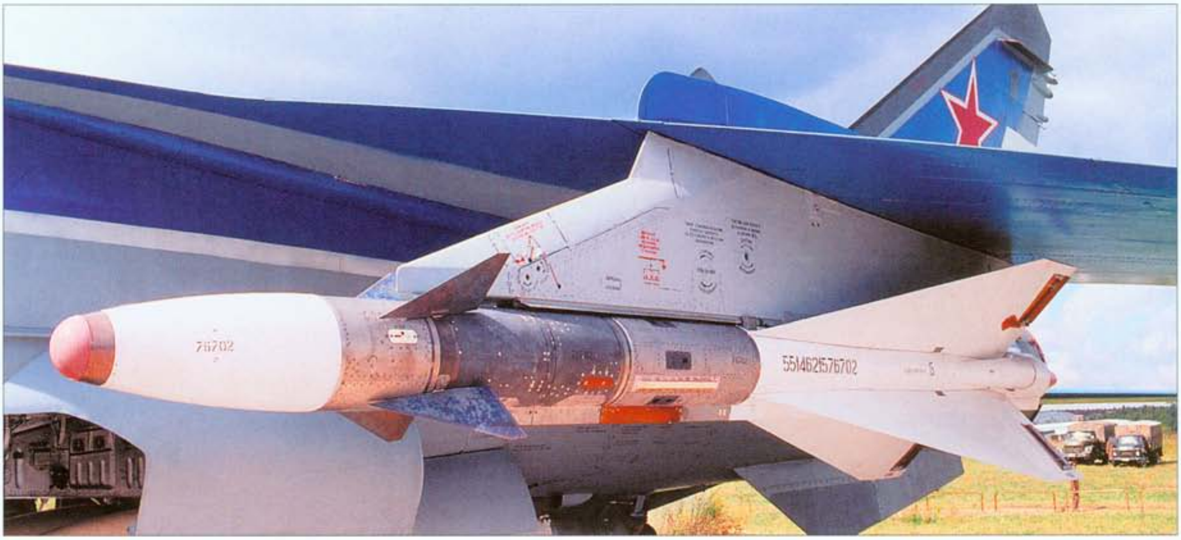
◄
An R-40TD on display at an airshow; the IR seeker head is visible.

Another view of the R-40TD on the wing. The modular design of the body is clearly visible (some sections are painted, others are not); again there are flush aerials for the radar proximity fuse on both sides of the body.
▼



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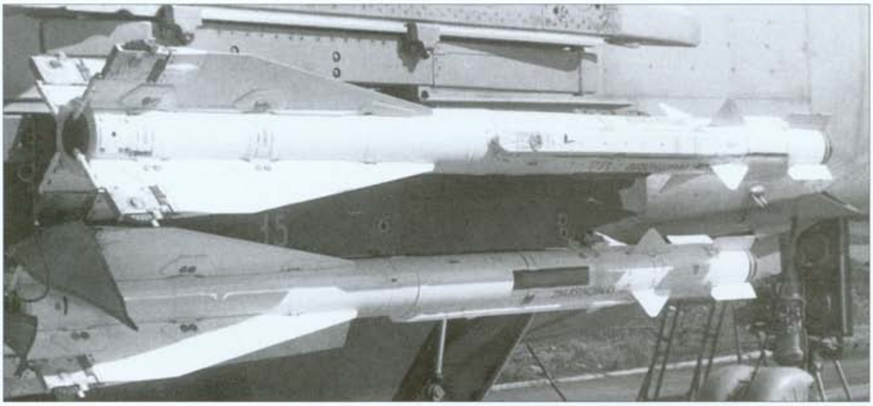
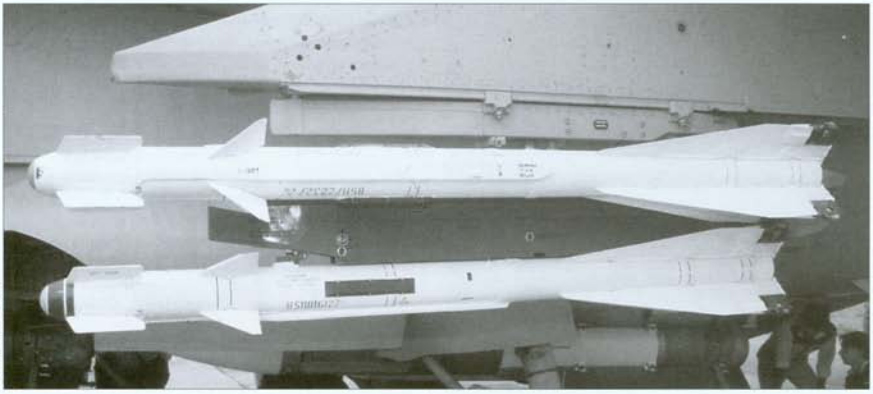
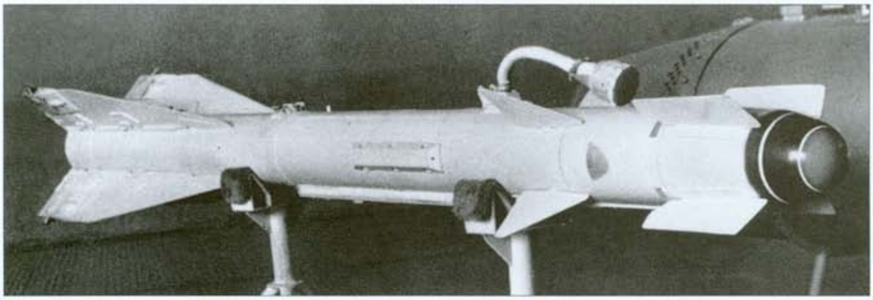

Via Nikolay Popov

◄
A pair of R-460M IR-homing 'dogfight missiles' on an APU-60-2 rack attached to the starboard inboard wing pylon. The outboard missile is carried on a horizontally positioned launch rail, hence the ventral wiring conduit is clearly visible here. Note the rollerons built into the fins.


Via Nikolay Popov

◄
Two more R-60Ms on the port side APU-60-2. The APU-60-2 comes in two non-interchangeable versions (port and starboard). Note the differently coloured seeker heads.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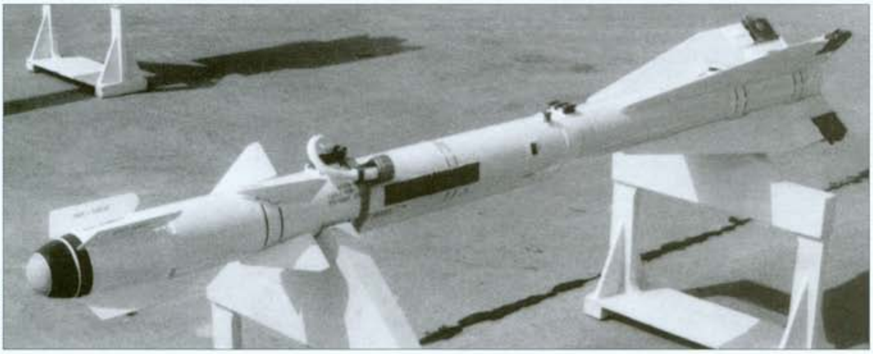
◄
An R-60M on a display stand. This view shows the fixed canards ahead of the rudders, the flush fuse aerials and the cable connecting the missile to the weapons control system.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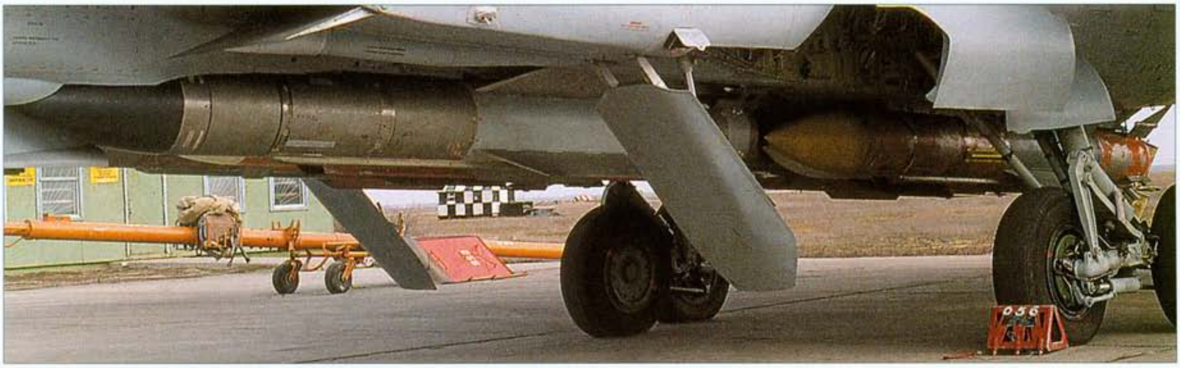
◄
Another R-60M on display at one of the Moscow airshows.



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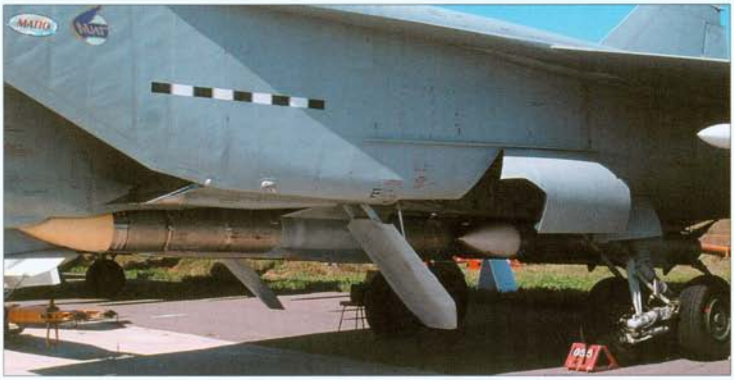

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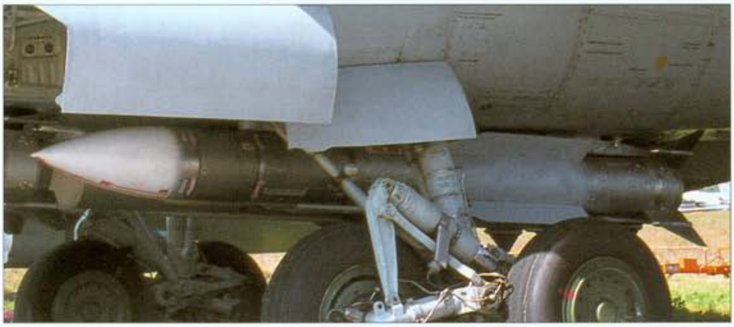
▲
Six R-37 ultra-long-range AAMs under the belly of MiG-31M '056 Blue' at Akhtoobinsk. Note that the missiles are painted differently; the orange-painted ones are probably instrumented test rounds.

◄
During its first public appearance at the MAKS-97 MiG-31M '057 Blue' also carried six R-37s.



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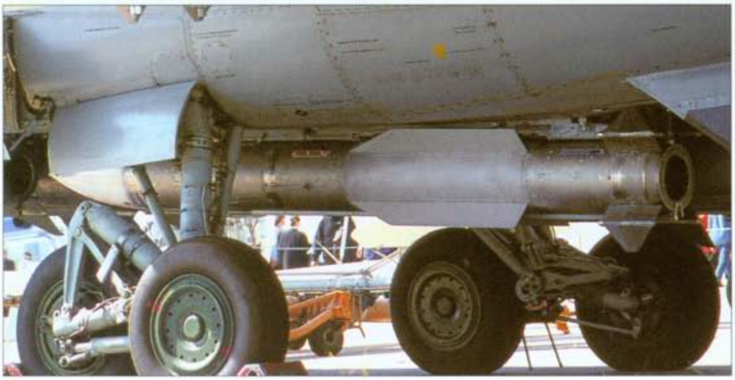
◄◄
Two views of the port R-37 in the rear row under the fuselage of MiG-31M '057 Blue'. Outwardly the R-37 appears similar to the R-33 to which it is related; however, it has differently shaped fins and rudders (the latter are triangular, not trapezoidal).

This view shows clearly the positioning of the R-37s three-abreast under the MiG-31M's fuselage. Note that the forward row is positioned immediately aft of the nosewheel. well and the nose gear doors feature special bulges to fit around the radome of the centre missile!
▼



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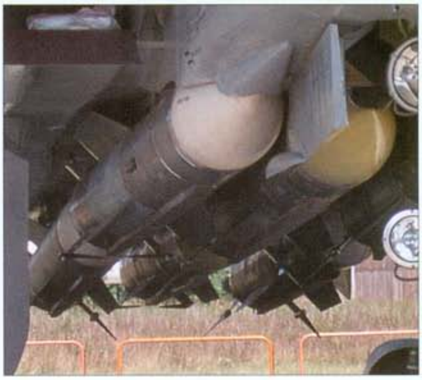

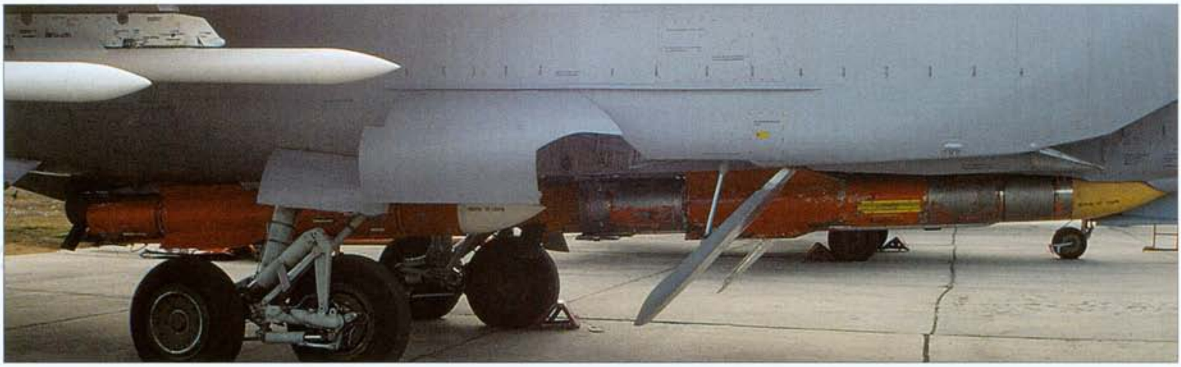

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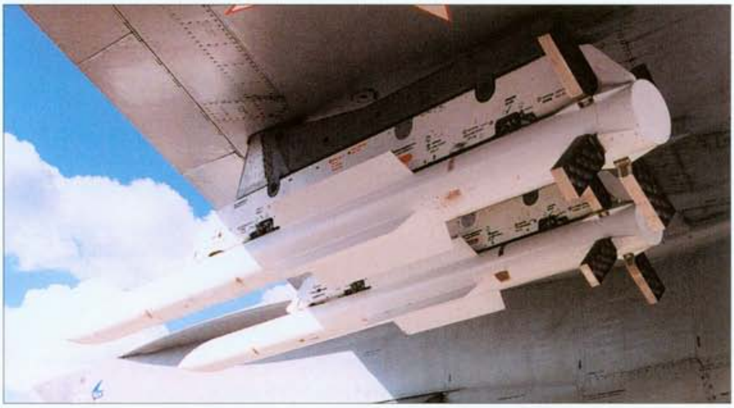
▲
Another view of the R-37s under the fuselage of '056 Blue'. The paintwork on some of the missiles shows signs of considerable wear and tear.

►
A pair of R-77 (RVV-AE) medium-range AAMs under the wing of MiG-31M '057 Blue'. These missiles are quite obviously dummies, lacking rocket motor nozzles. The R-77 is immediately recognisable by the lattice-shaped rudders which create minimum drag when aligned but generate a considerable side-force when deflected.



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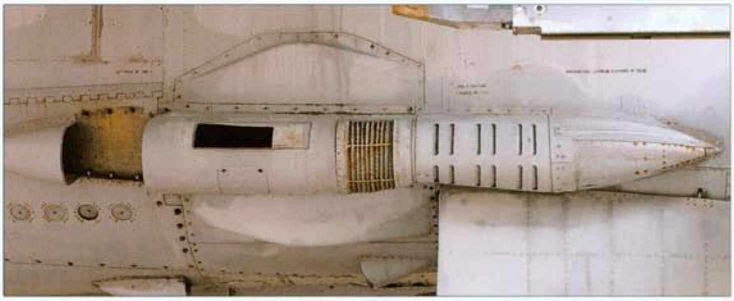
►
The GSh-6-30 six-barrel Gatling cannon is installed in a fairing above the starboard mainwheel well. The fairing is empty on this preserved example and part of the gun cowl is missing. Note the ogival nose fairing which rotates out of the way before firing, the blast gas suction louvres and the spent case ejector chute.



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Two more views of the four R-77s carried by the MiG-31M on widely spaced small pylons under the outer wings.
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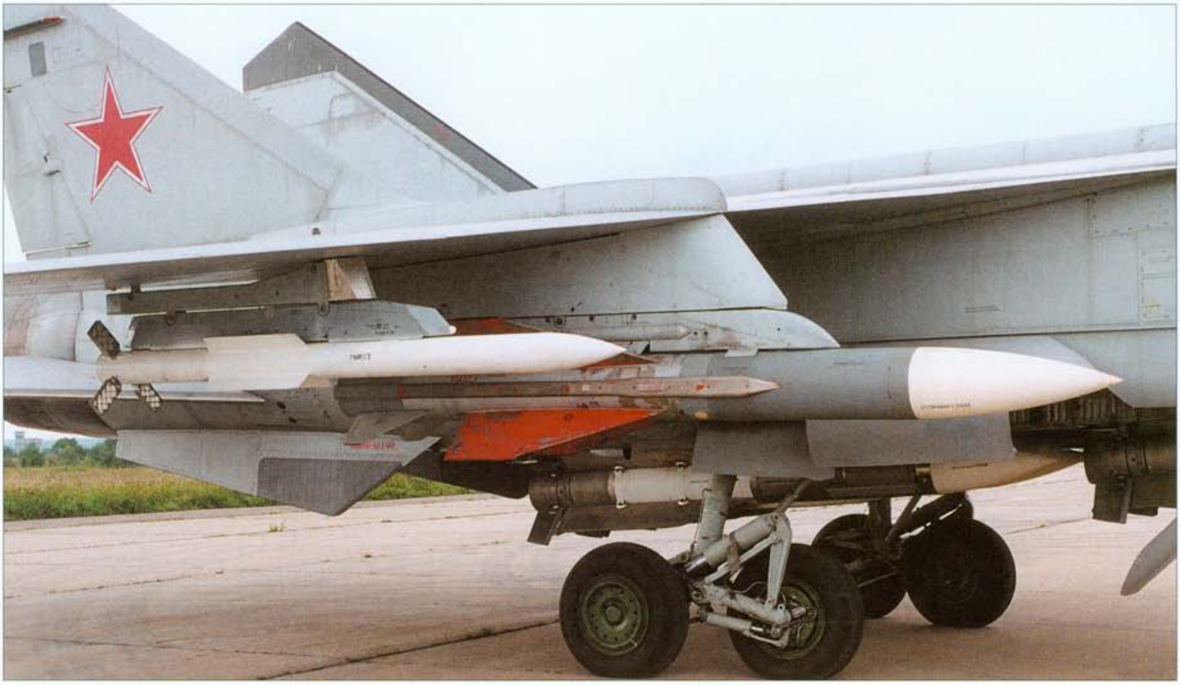

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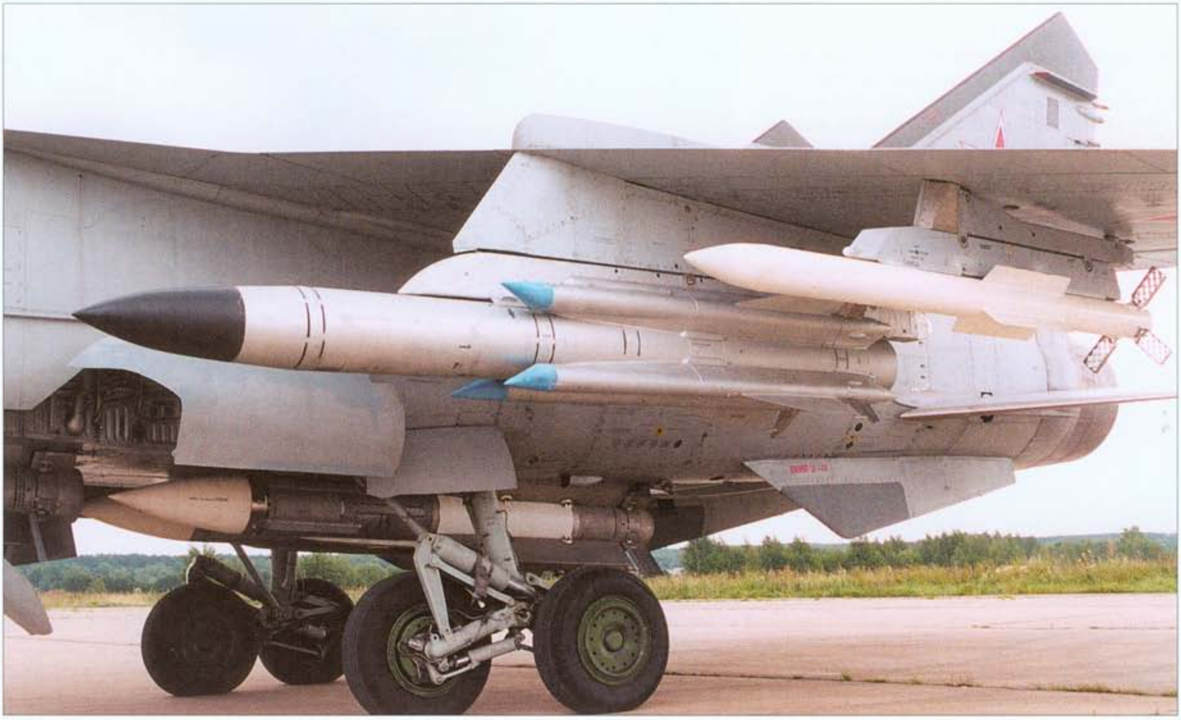
▲
A Kh-58U anti-radiation missile (inboard) and a dummy R-77 AAM under the starboard wing of the MiG-31BM prototype ('58 Blue').

A Kh-31P anti-radiation missile (inboard) and a dummy R-77 AAM under the starboard wing of MiG-31BM '58 Blue'.
▼



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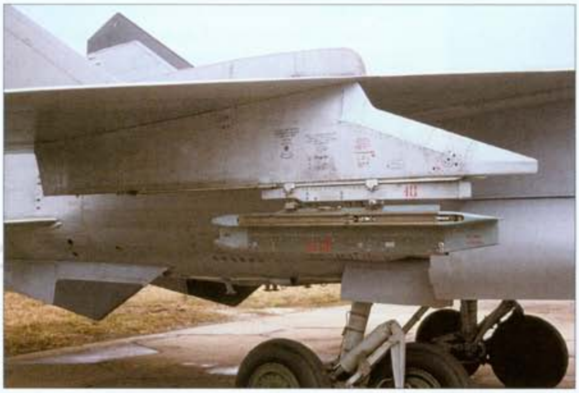
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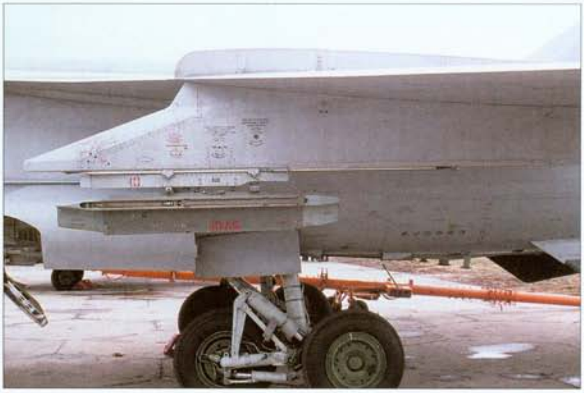
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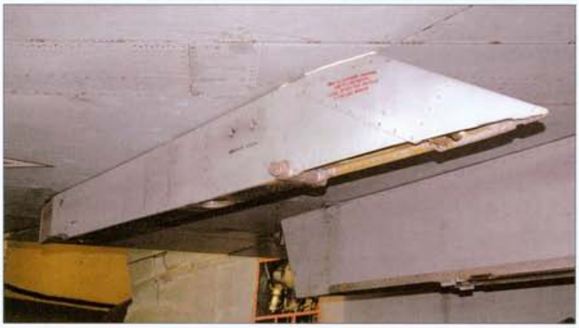
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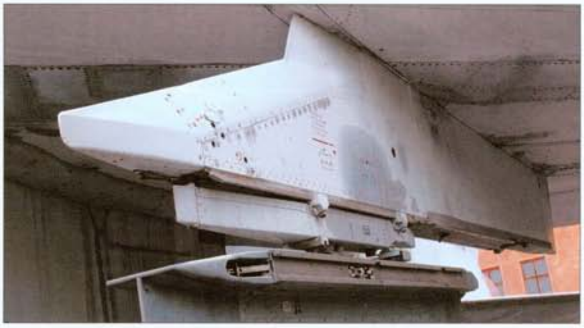
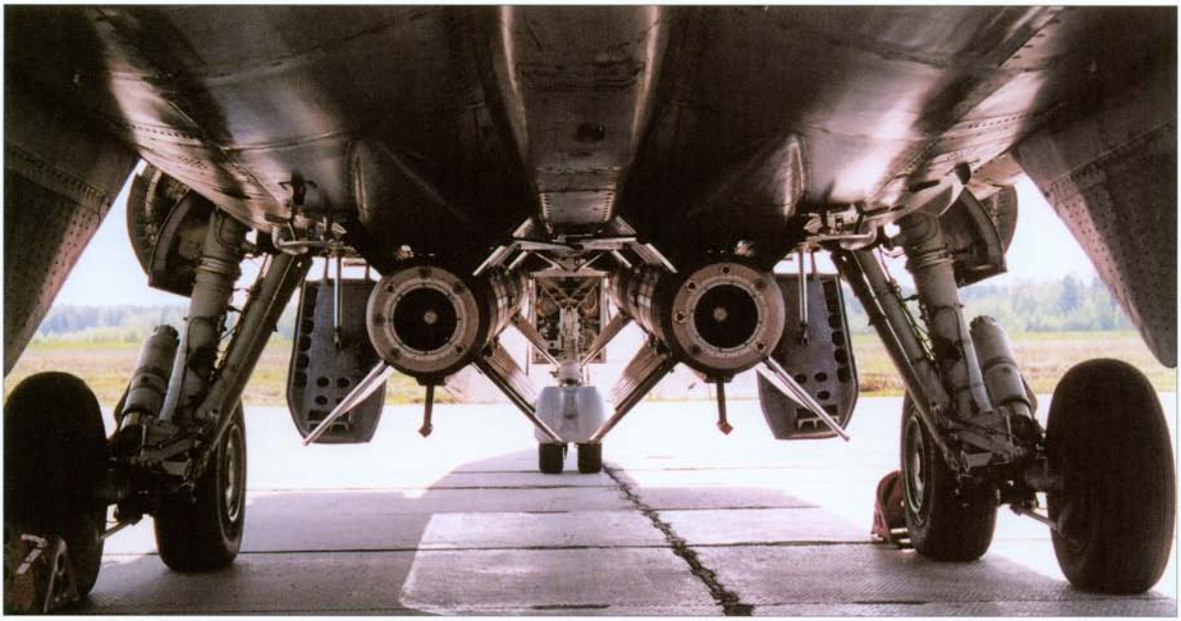
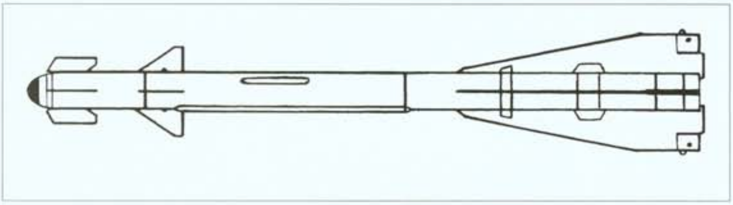

Yefim Gordon

▲
The photos in the top row and above right show the main (inboard) wing pylons of MiG-31 '10 Red' with APU-60-2 missile adapters attached; the APU-60-2s are marked '10PR' (*pravyy* – starboard) and '10LV' (*levyy* – port). Shown above left is one of the detachable outer wing pylons.

A view under the belly of a MiG-31B with R-33 missiles attached.
▼


Vyacheslav martyniuk

Yefim Gordon



▲▲
Another view of the port inner wing pylon with an APU-60-2.

▲
A drawing of the R-60M missile. This drawing is NOT to the same scale as the drawings below.

▼
A drawing of the R-40TD medium-range IR-homing AAM with a long-burn rocket motor.

▼▼
A drawing of the R-40T medium-range IR-homing AAM on the pylon. Note the different tail fairing with the mid-course guidance aerial.

The upgraded MiG-31B and MiG-31BS can carry up to four R-33S missiles with higher performance and provisions for a nuclear warhead.

On the MiG-31M the weapons range is further expanded by the integration of R-37 ultra-long-range AAMs and R-77 (RVV-AE) medium-range active radar-homing AAMs. As compared to the R-33, the R-37 had higher manoeuvring G limits, longer launch range and better ECM resistance, especially when used against low-flying targets or groups of aircraft. Thanks mainly to the more powerful rocket motor with a much longer burn time and the completely new control system architecture the R-37 enables the aircraft to attack targets at up to 300 km (186 miles) range. The number of long-range AAMs is increased from four to six by placing two more pantographic ejector racks on the centreline. The R-37 has a launch weight of 450 kg (990 lb) and a 60-kg (130-lb) warhead; all four stabilisers fold, unlike the R-33 where only two of the four stabilisers have this feature.

Additionally, four R-77 (RVV-AE) AAMs can be carried on underwing pylons. The R-77 has a launch weight of 175 kg (385 lb) and a range of 90 km (56 miles).

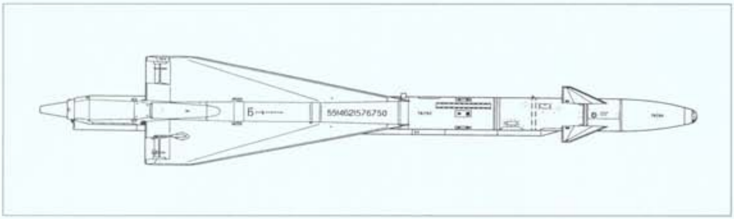
The multi-purpose versions (MiG-31E/MiG-31FE and MiG-31BM) can carry up to six Kh-31P, Kh-25MP or Kh-25MPU anti-radiation missiles, up to three Kh-59 or Kh-29T TV-guided air-to-surface missiles or up to two Kh-59M ASMs, up to six 1,500-kg (3,310-lb) KAB-1500 guided bombs or up to eight 500-kg (1,102-lb) KAB-500 bombs.

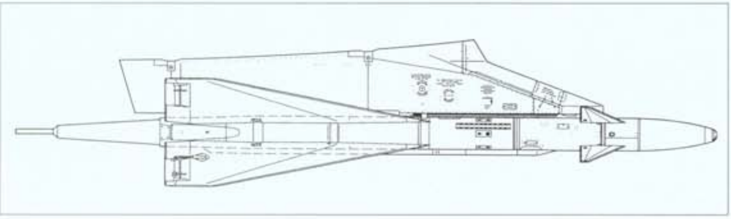
The MiG-31 *sans suffixe* (*izdeliye* 01 and *izdeliye* 01DZ), MiG-31B and MiG-31BS have a 23-mm (.90 calibre) Gryazev/Shipoonov GSh-6-23 or GSh-6-23M six-barrelled Gatling cannon with linkless feed in a fairing above the starboard mainwheel well. The rate of fire is 8,000 rpm and the ammunition supply is 260 rounds. Each round weighs 200 g; muzzle velocity is 700m/sec When the cannon is not in use the muzzle is closed by a door to reduce drag. The MiG-31M has no cannon.

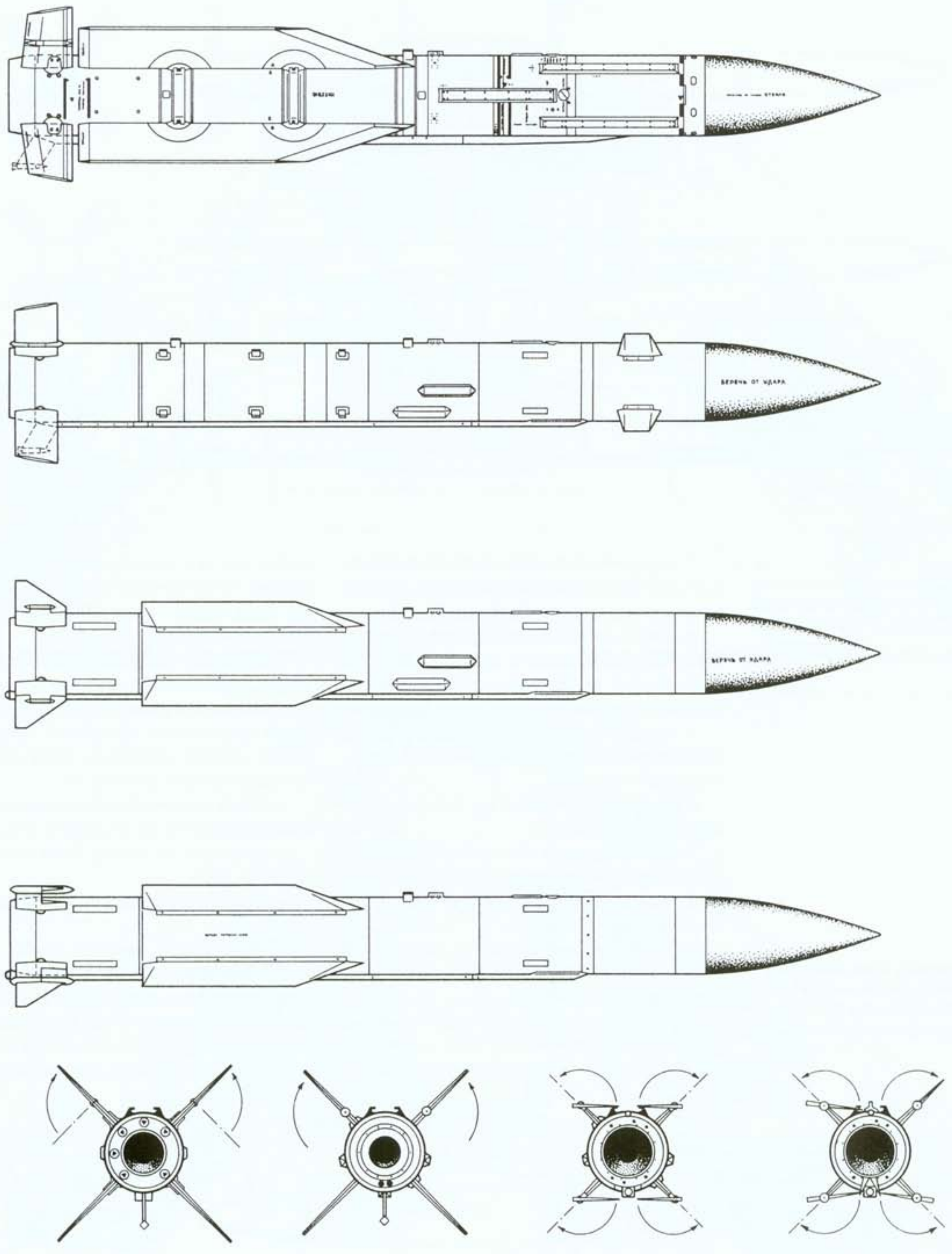
Avionics and Equipment

Weapons control system: The MiG-31 *sans suffixe* (*izdeliye* 01 and *izdeliye* 01DZ) have an RP-31 (S-800) Zaslon weapons control system featuring both radar and IR targeting capability. Aerial targets can be detected at a range of 120-130 km (74.5-80.75 miles). Maximum tracking range for a medium bomber-sized target is 200 km (124 miles) in head-on mode and 120 km (74.5 miles) in pursuit mode; maximum tracking range for a fighter-type target with a minimum RCS of about 2 m^2 (21.5 sq ft) is 90 km (55.9 miles) and 70 km (43.5 miles) respectively. The WCS is built around a phased-array fire control radar with field of view of ±70° (±120° in certain modes) in azimuth and +70°/–60° in elevation. Hence the radar confers a look-down/shoot-down capability – also against targets incorporating stealth technology, helicopters and cruise missiles.

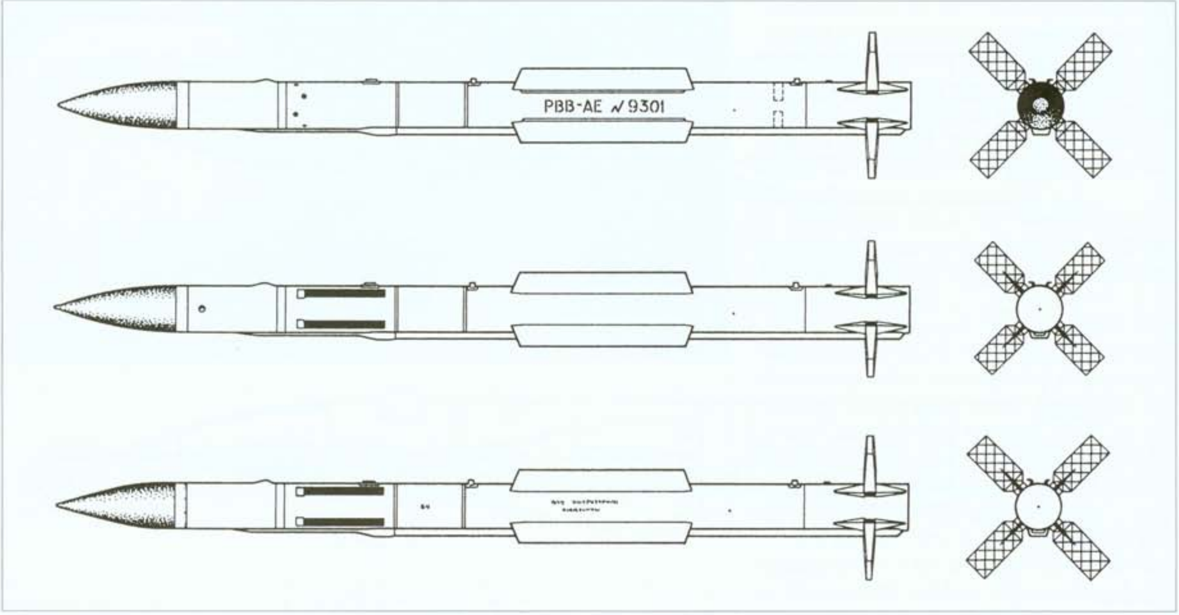
In conjunction with the interceptor's other avionics the RP-31 Zaslon WCS provides the following capabilities:







▲
The side views depict, top to bottom: the R-33; a wingless version of the R-37 carried on the centreline hardpoint by MiG-31M '056 Blue'; and the standard R-37 with the rudders deployed and folded. The rear views depict the R-33 (left and far left) and the R-37 (right and far right).

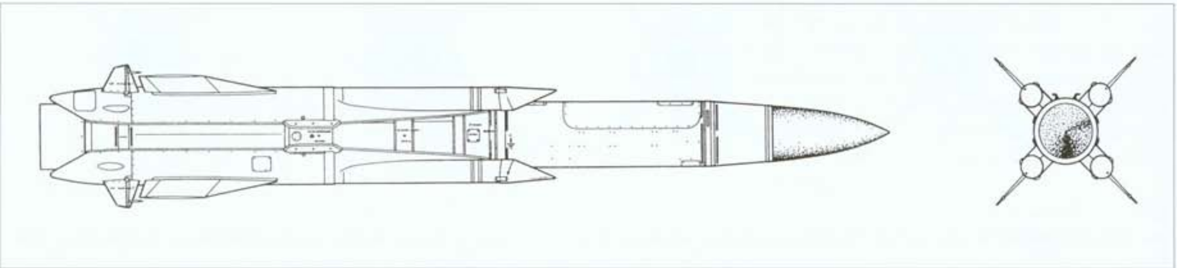


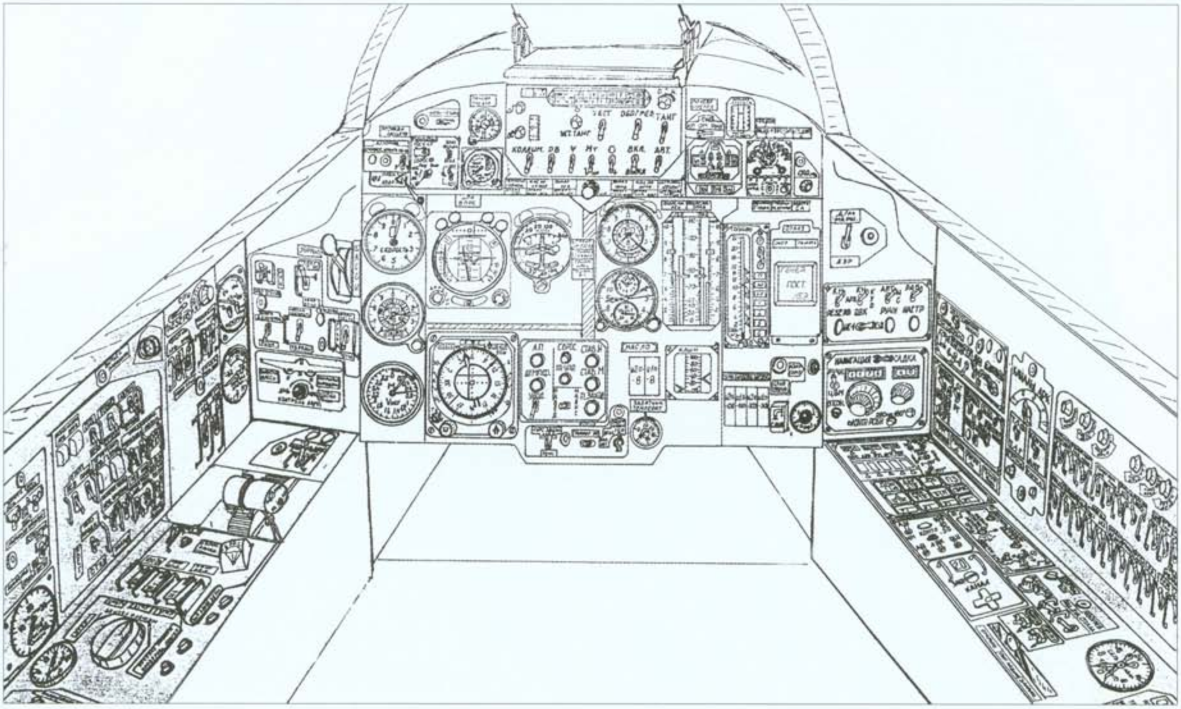
▲
Three different versions of the R-77 (RVV-AE) medium-range AAM. The one in the middle has shorter rudders.

- engagement of aerial targets singly and as a group in ground controlled intercept, airborne guidance and autonomous (search) modes;
- control of the actions of aircraft in a group from the group leader's aircraft during the main phases of the action, including target approach, attack and breaking off the attack;
- uploading target data from the group leader's aircraft to an automated ground control system (AGCS);
- tracking ten targets at a time while attacking four priority targets;
- displaying target data and information on other aircraft in a group (supplied by the radar, IRST, AGCS and the wingmen) on the tactical situation display (TSD);
- generating and displaying data source designators, the trajectories of the targets and the wingmen on the TSD;
- generating and displaying data enabling combat formation-keeping, data search (in manual mode or using incoming target information or the image on the tactical situation display), target selection and distribution (by the flight leader, in the latter case), attack commencement and completion;
- displaying navigation/attack information in various co-ordinate systems on the TSD;
- manual entry and relay to the wingmen of target co-ordinates, designated target information, control commands, flight mode and formation keeping commands;
- missile launch with initial target data down loading while the missile is still on the pylon;
- zeroing in on enemy ECM aircraft and attacking them;
- target tracking within a 140° sector.

The RP-31 Zaslon weapons control system includes a target search/track subsystem, a weapons selector (armament control) subsystem and weapons interface modules. It is linked to the aircraft's principal avionics by the automatic control system, the navigation suite,

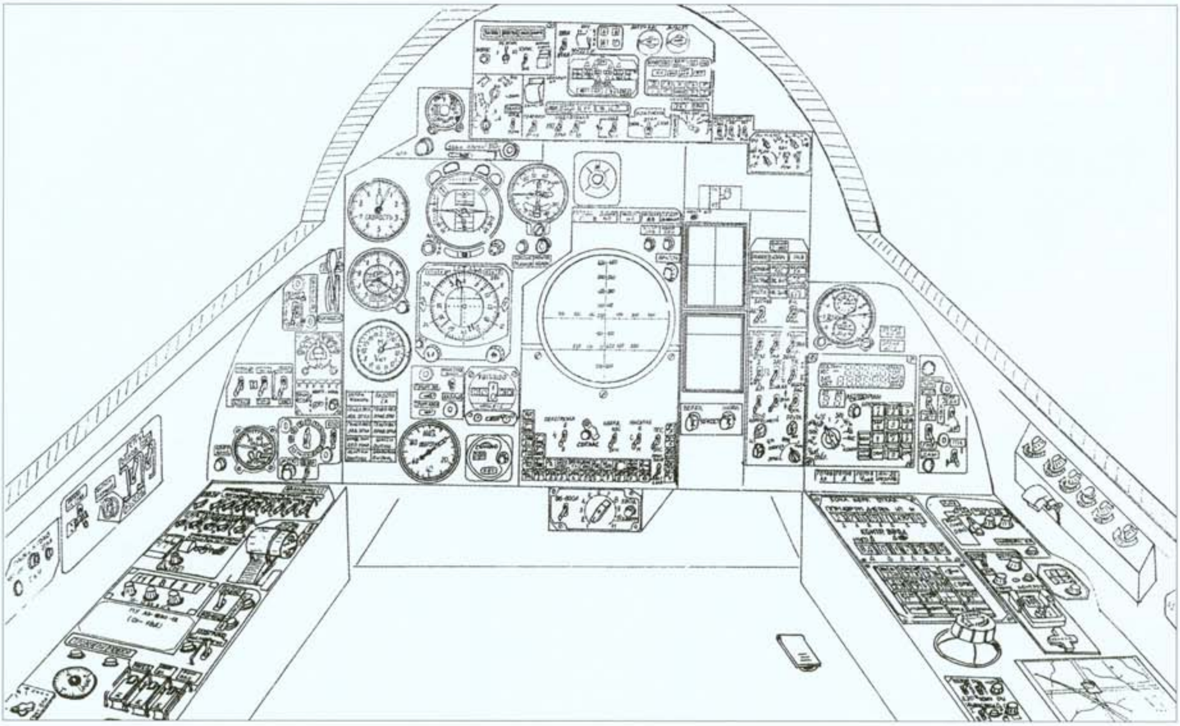
A drawing of the Kh-31P anti-radiation missile carried by the MiG-31BM. The Kh-31A anti-shipping version is outwardly identical.
▼

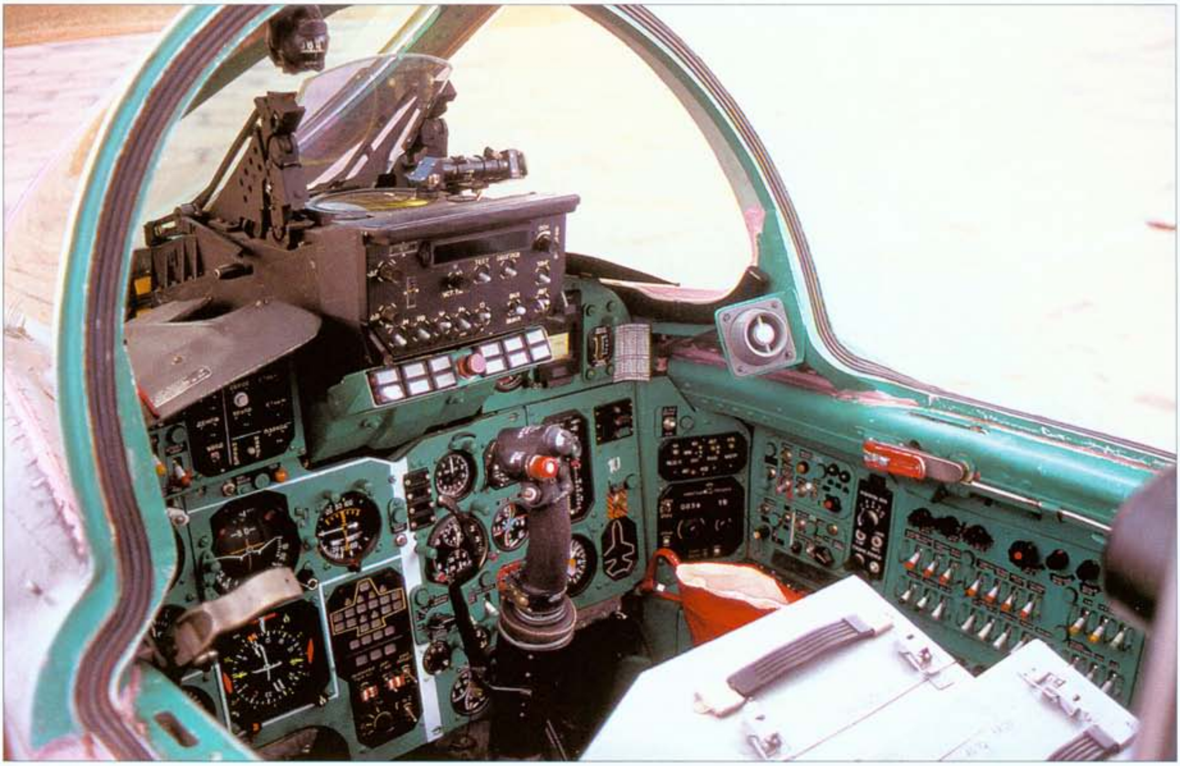




▲
The pilot's cockpit of the MiG-31. The control stick is omitted for clarity.

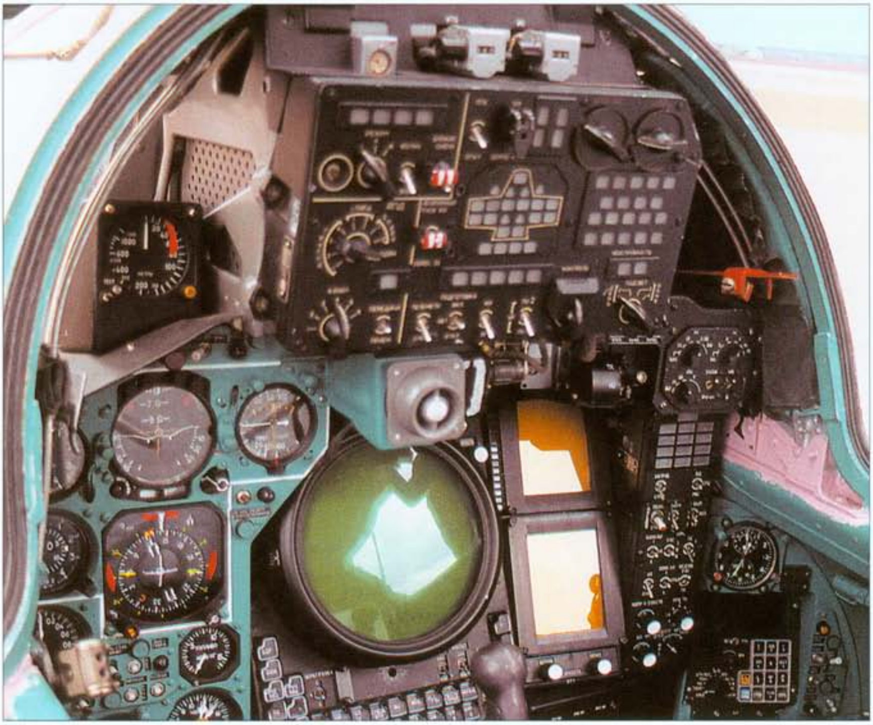
The weapons systems operator's cockpit of the MiG-31.
▼





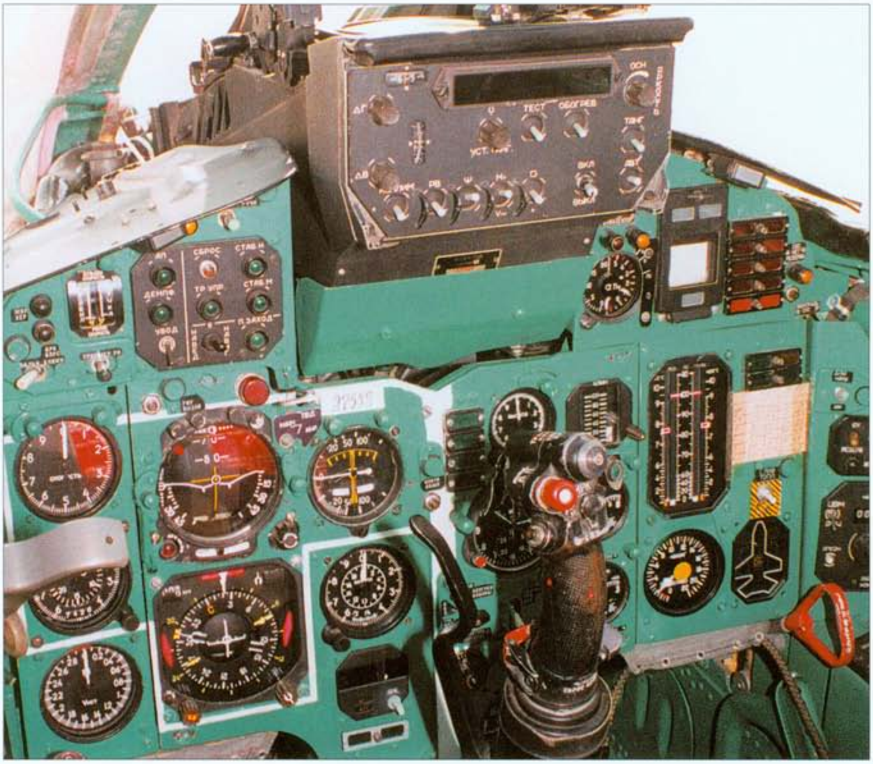
Yefim Gordon

▲
The pilot's cockpit of '10 Red', an IFR-capable MiG-31 (*izdeliye* 01DZ). The top of the instrument panel is occupied by the PPI-70V head-up display. Note the ventilation nozzle on the right-hand side of the windshield frame.



Yefim Gordon

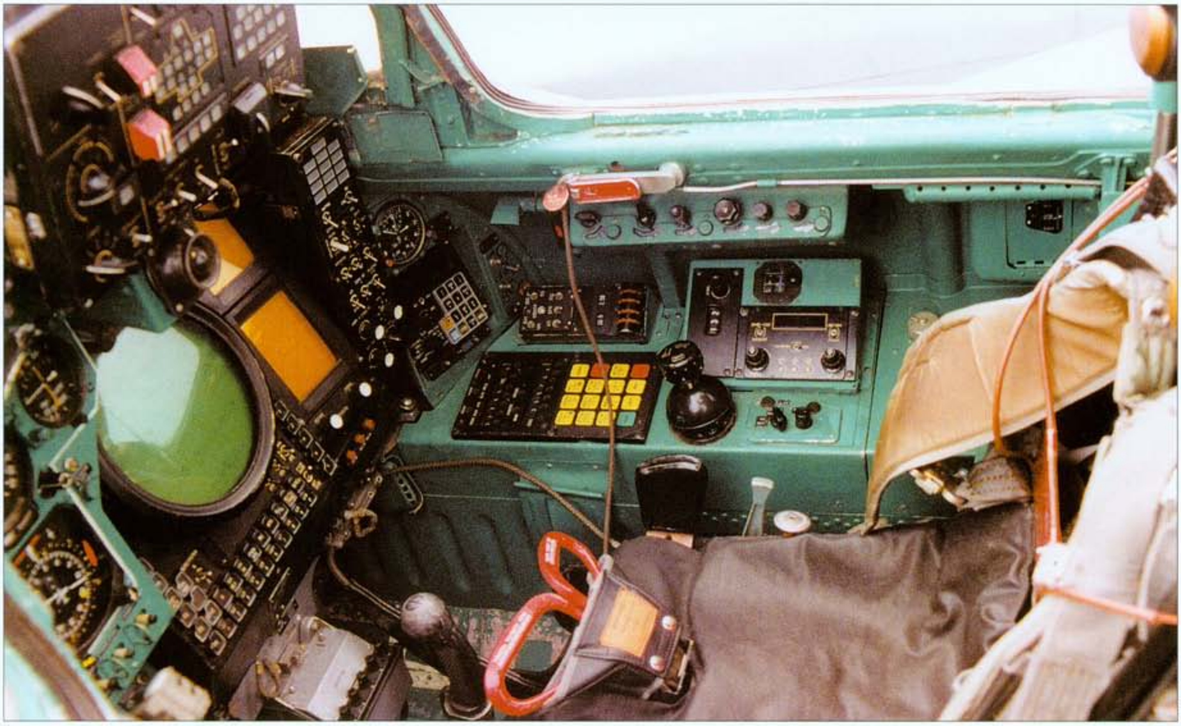
►
The WSO's cockpit of MiG-31 (*izdeliye* 01DZ) '10 Red'. Again, there is a ventilation nozzle under the external stores selector panel (above the radarscope); the rubber-bladed cooling fans that used to be typical of Soviet aircraft are no more.



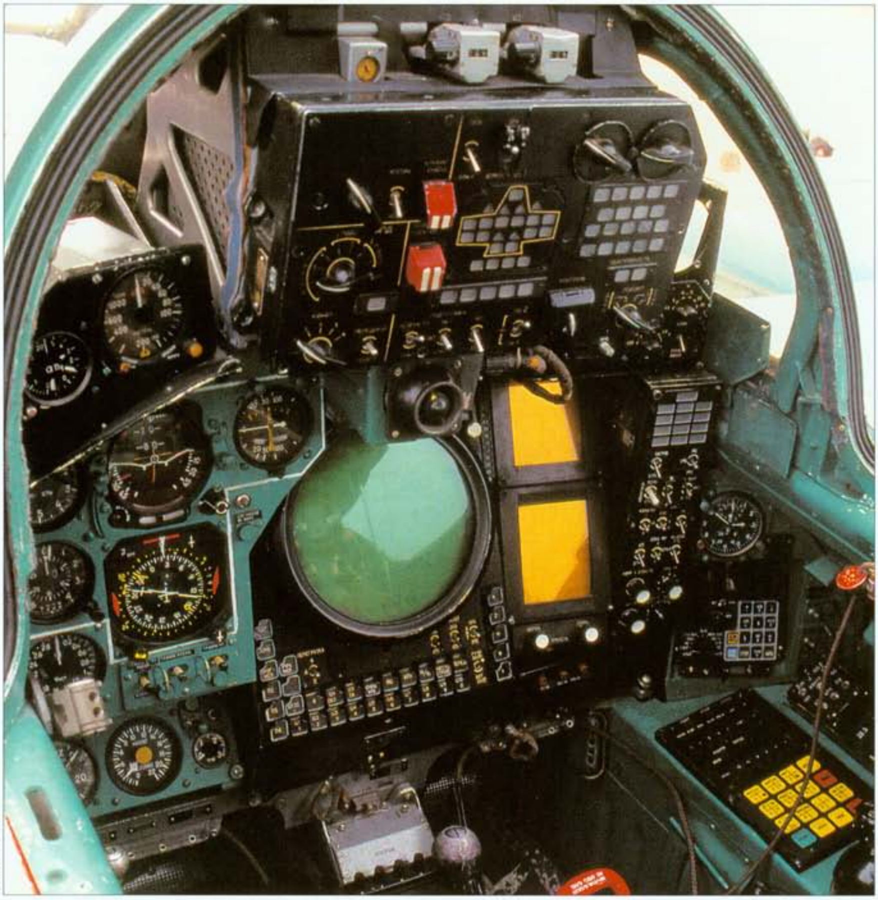
Yefim Gordon

◄
The forward cockpit of the MiG-31LL ejection seat testbed ('79 Red').

The rear cockpit of MiG-31LL '79 Red'. Note the telescopic emergency control stick immediately ahead of the red ejection handles of the WSO's K-36DM ejection seat.
▼



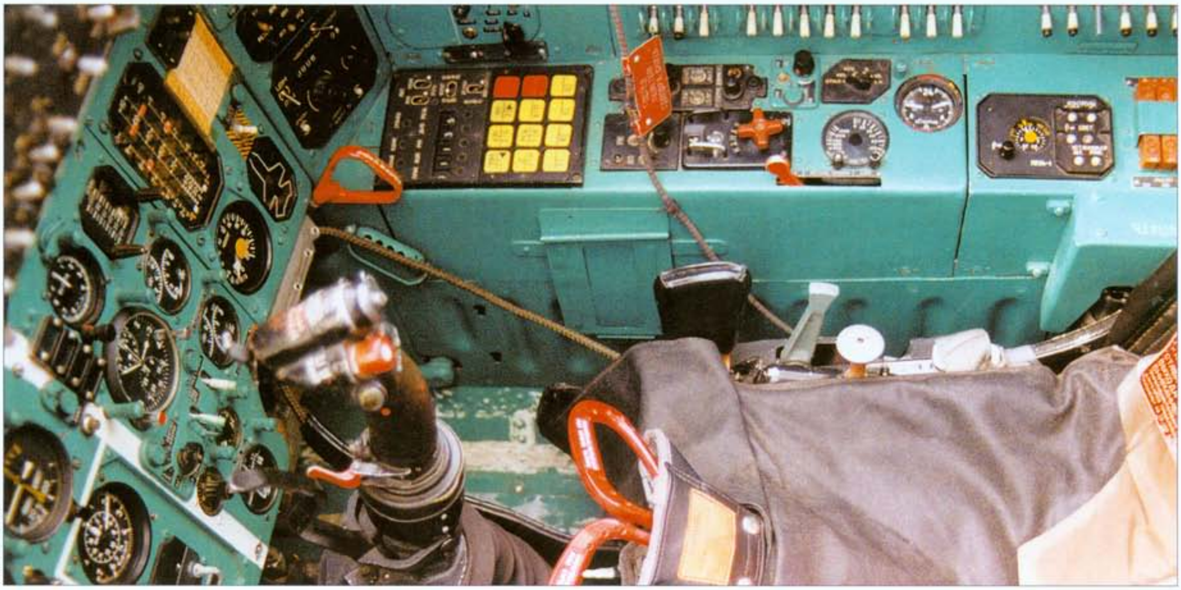
Yefim Gordon



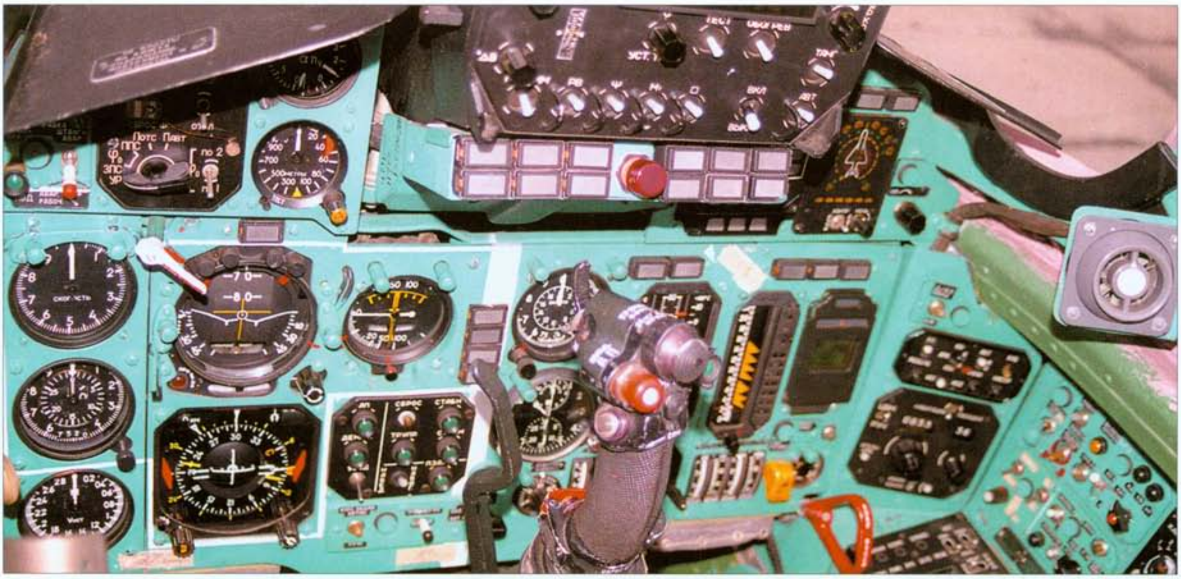
◄ Another view of the rear cockpit of MiG-31LL '79 Red'. The aircraft appears to have a perfectly standard instrument panel with all the usual switches, radarscope and tactical situation display.

Yefim Gordon

The starboard console in the forward cockpit of MiG-31LL '79 Red'. ▼

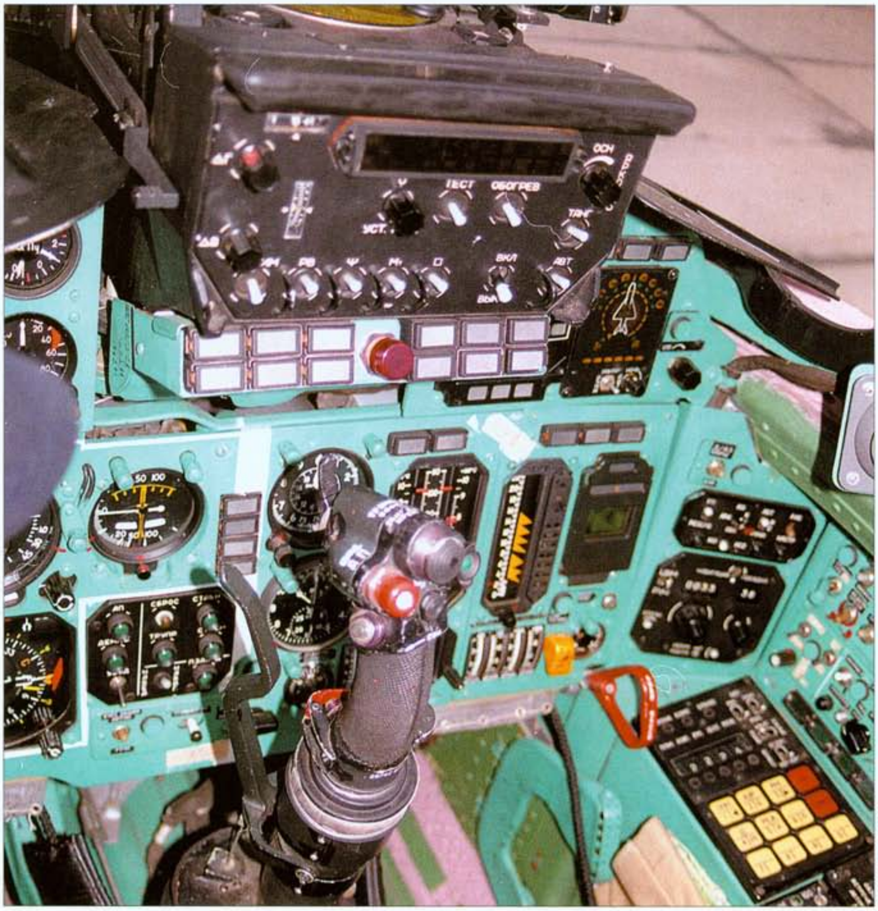


Yefim Gordon



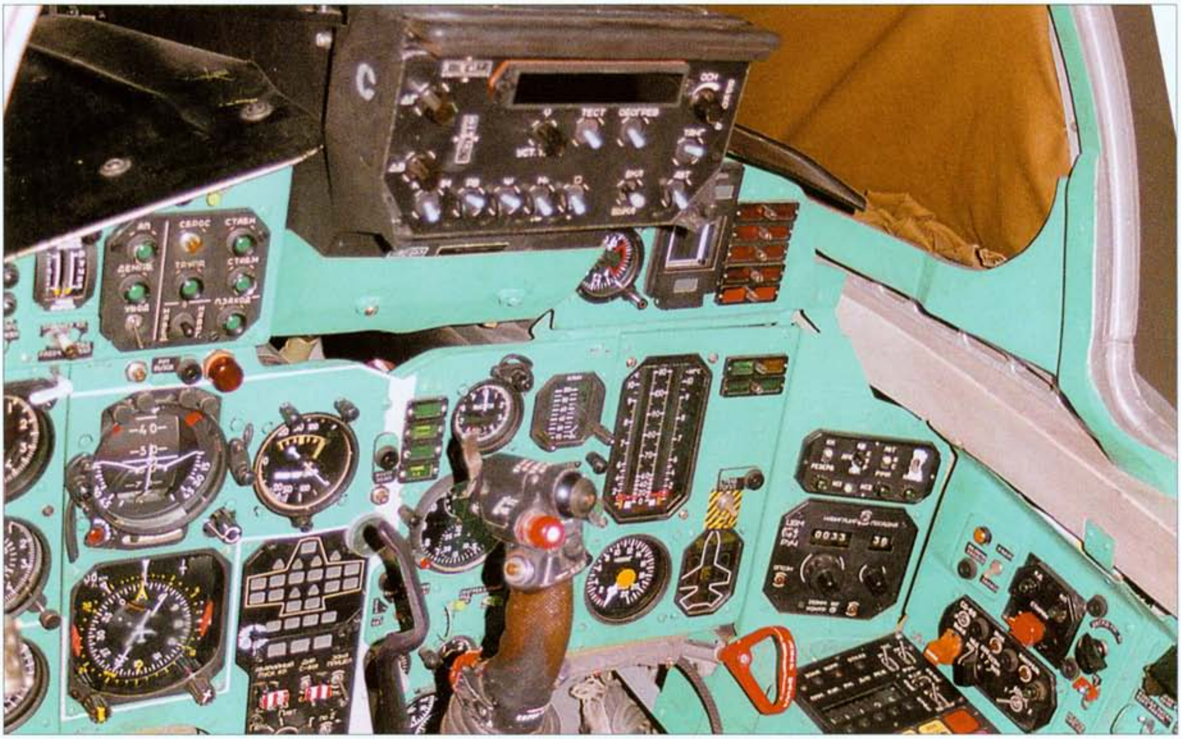
Sergey Sergeyev

▲
The pilot's cockpit of a MiG-31B. The instrument panel is is rather different from that of the MiG-31 *sans suffixe*.

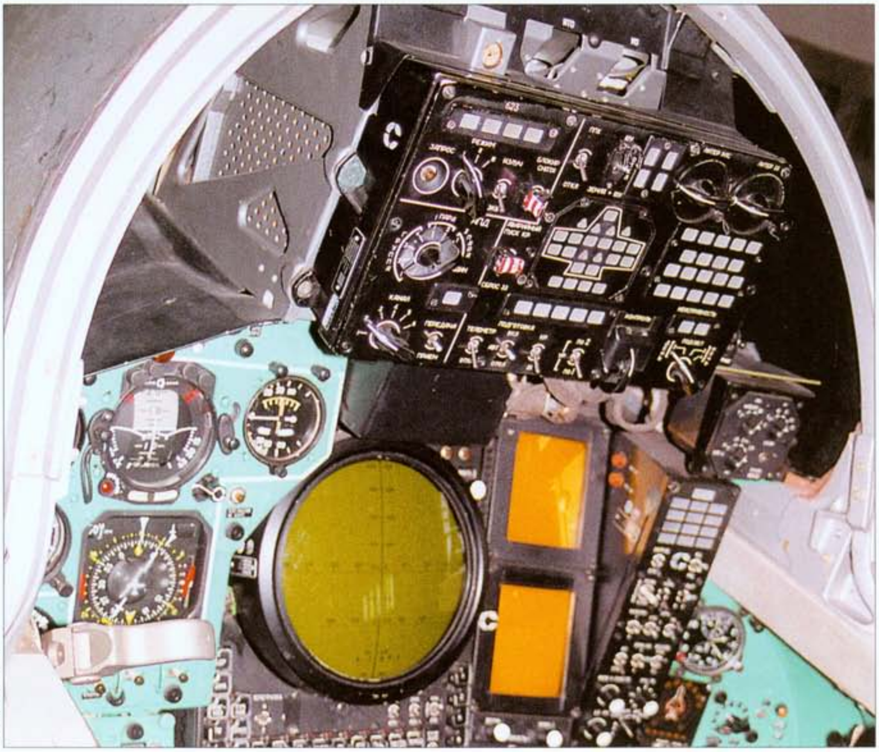


Sergey Sergeyev

►
Another view of the instrument panel in the MiG-31B's forward cockpit. The bank of switches at the top is for the HUD.



Sergey Sergeyev

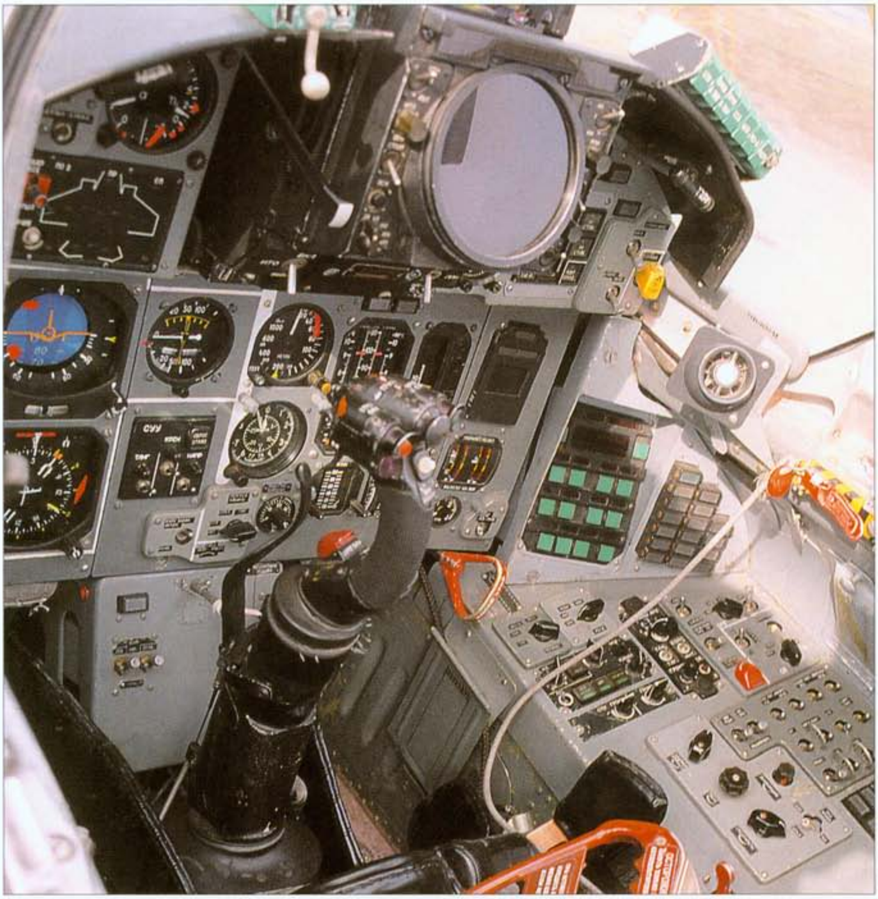


Sergey Sergeyev

▲
The former PVO training centre at Savasleyka AB has a MiG-31 flight simulator. This is a view of its forward cockpit. Note the canvas covering the open cockpit when not in use.

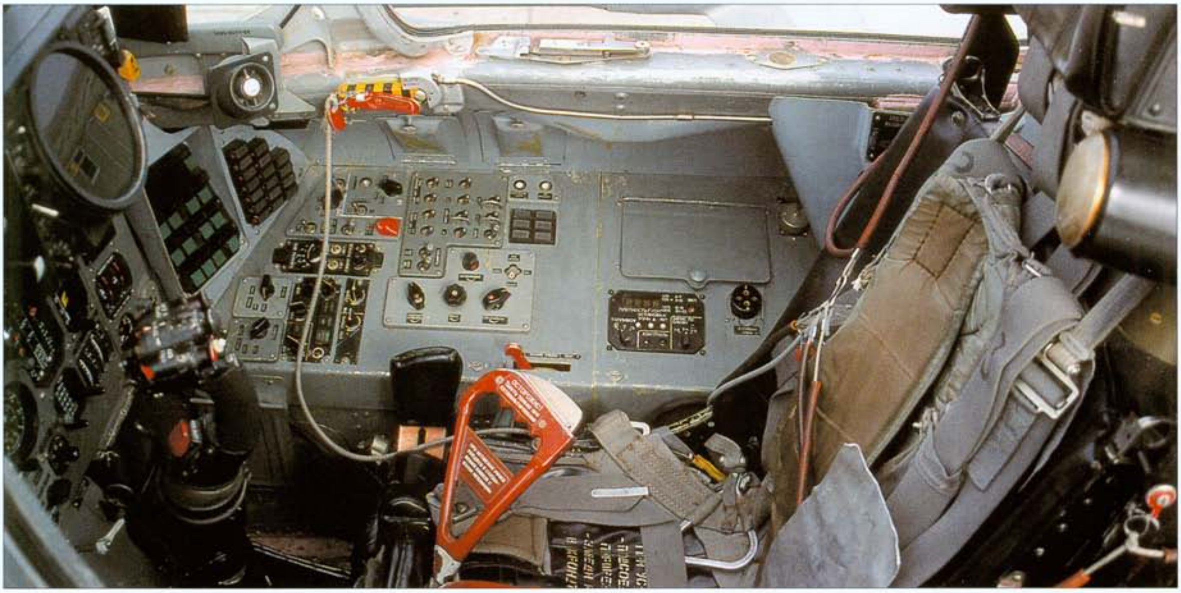
◄
The rear cockpit of MiG-31 flight simulator at Savasleyka AB.

▶
The cockpits of the MiG-31M are markedly different from those of the 'first-generation' MiG-31; the forward cockpit of '056 Blue' is illustrated here. A small radarscope is provided at the top of the instrument panel. Interestingly, the intense turquoise colour normally found on Soviet aircraft (civil and military alike) has given way to a Western-style medium grey shade.

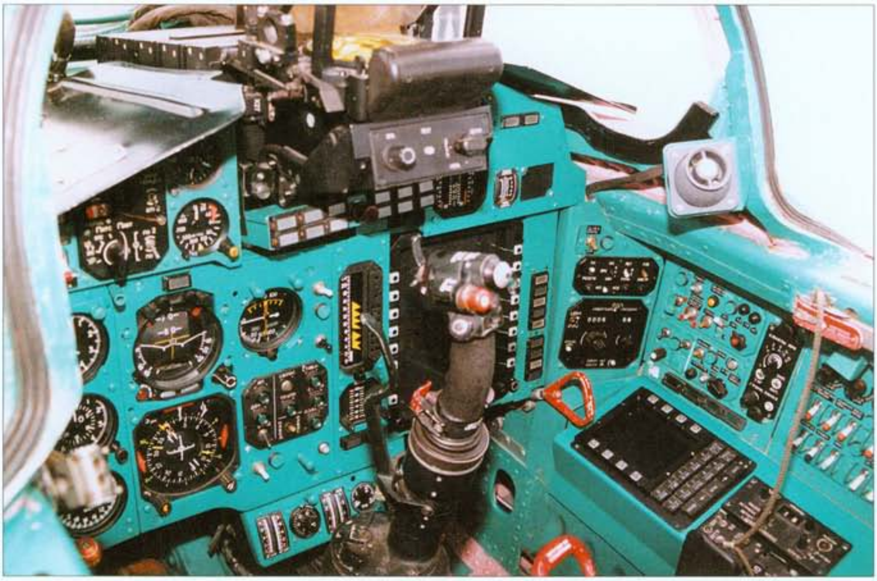


Yefim Gordon

The starboard console in the forward cockpit of MiG-31M '056 Blue'.
▼



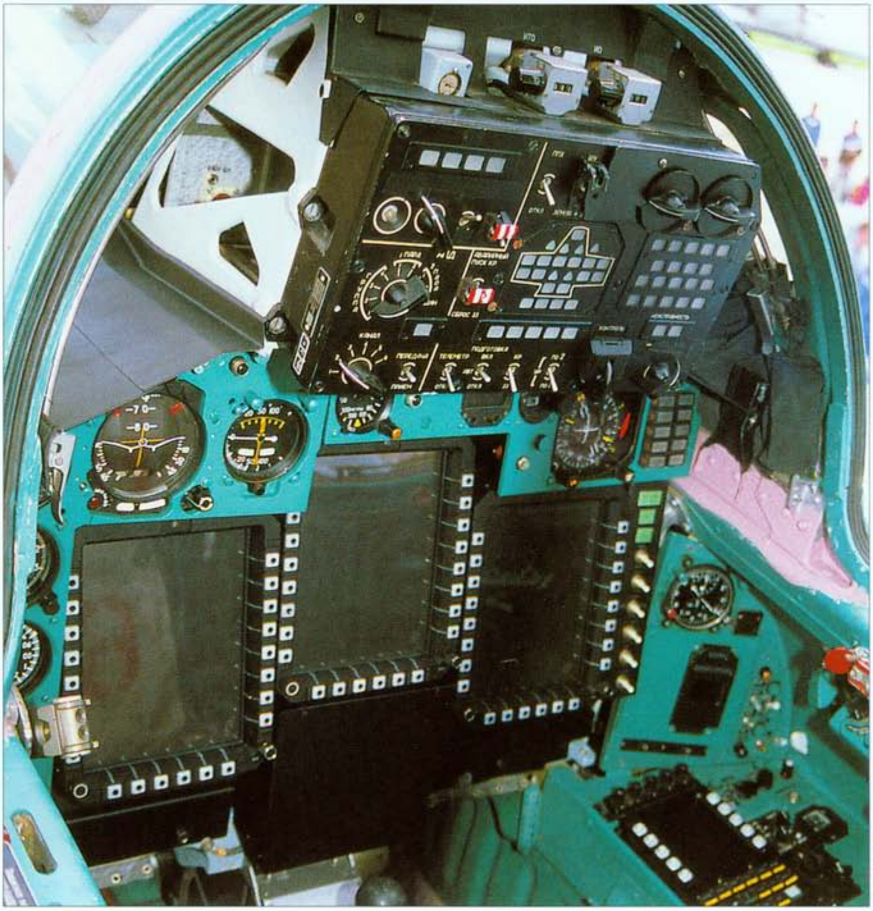
Yefim Gordon



Yefim Gordon

◄

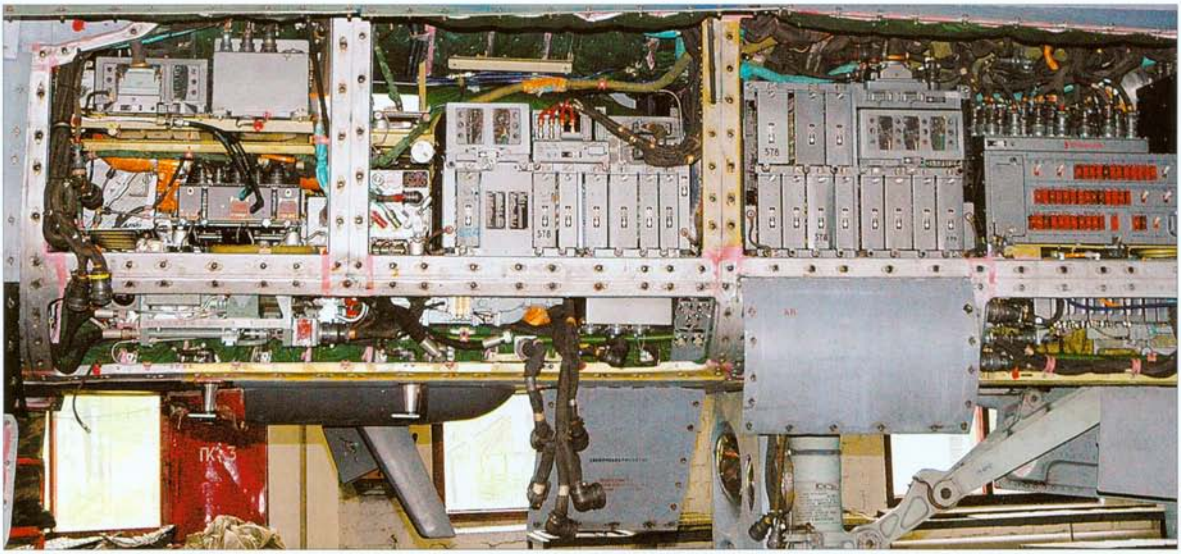
The forward cockpit of the MiG-31BM prototype '58 Blue'. Note the two multi-functional liquid-crystal displays – a large one on the main instrument panel and a smaller one with a keypad on the starboard console.



Yefim Gordon

►

The WSO's cockpit of the MiG-31BM boasts no fewer than four MFDs – three large ones on the main instrument panel (identical to the one up front) and a smaller one with a keypad (of a different type) on the starboard console.

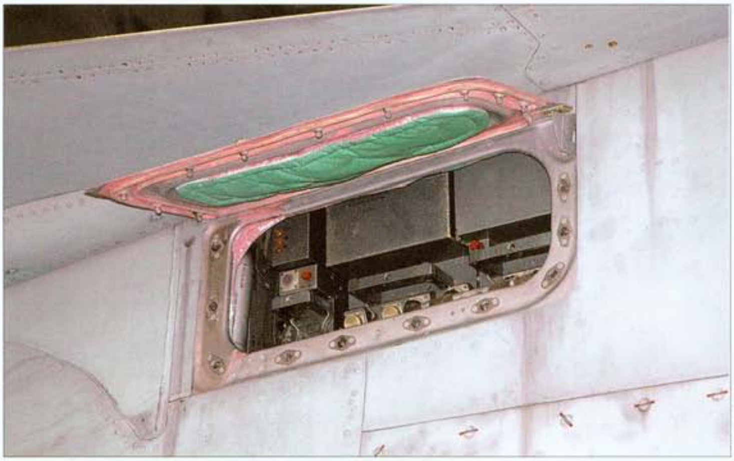

Yefim Gordon

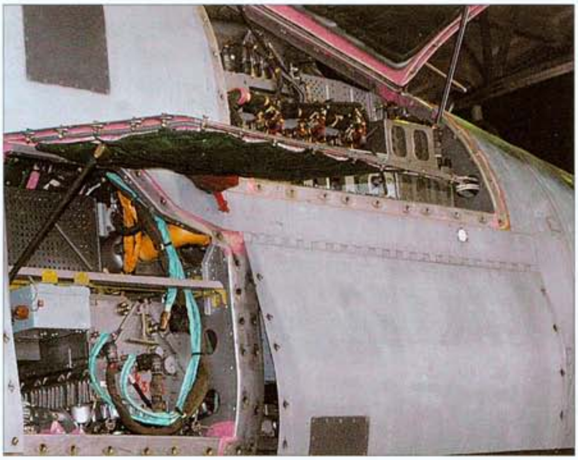
▲
The avionics bay on the port side of the MiG-31's forward fuselage. The open panels (normally held in place by Dzus fasteners) provide almost unrestricted access. Note the IRST pod on the left.

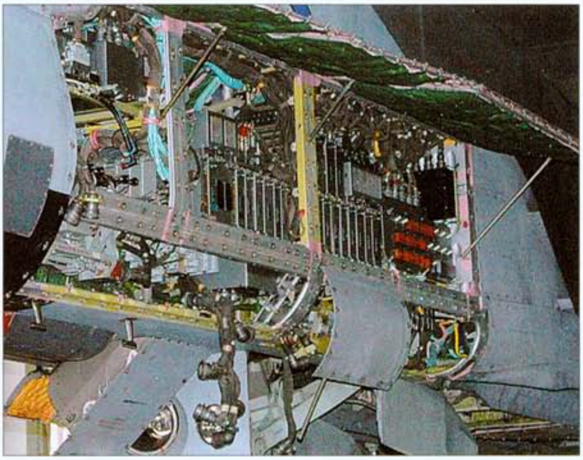
►
This panel under the starboard LERX gives access to a small avionics bay with line replaceable units (LRUs) featuring handles for extraction and carriage.

More avionics bays on the starboard side of the nose.
▼

Another view of the port side avionics bays. More panels hinge open on the underside.
▼►

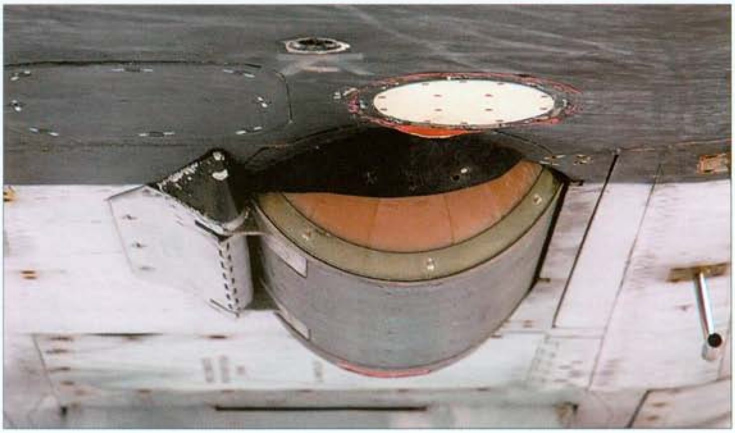

Yefim Gordon


Yefim Gordon


Yefim Gordon

Main Specifications of the RP-31 (S-800) Zaslon Weapons Control System

Target altitude, m (ft)	50-30,000 (164-98,425)
Maximum target speed, km/h (mph)	3,700 (2,300)
Number of targets attacked simultaneously	4
Flight automation in combat mode	Automatic and GCI controlled flight, SAU-155MP ACS
Armament:	
Long-range missiles	4 x R-33
Max launch range in head-on/pursuit mode, km (miles)	120/40 (74.5/24.8)
Medium-range missiles	2 x R-40D
Max launch range in head-on/pursuit mode, km (miles)	40/20 (24.8/12.4)
Short-range missiles	4 x R-60
Max launch range in head-on/pursuit mode, km (miles)	–/8 (–/5)
Cannon	1 x GSh-23-6
Calibre/ammunition supply	23 mm/260
Radar	Model 8B 'Leningrad' with B.01 phased array
Target detection range (target RCS = 3 m²/32.25 ft²), km (miles):	
head-on mode	120-130 (74.5-80.75)
pursuit mode	45-60 (28-37)
Target detection range (bomber-type target), km (miles):	
head-on mode	180-200 (111-124)
pursuit mode	60-80 (37-50)
Number of targets tracked simultaneously	10
Field of view:	
azimuth	±70°
elevation	+70/–60°
IRST	8TP
Target detection range in pursuit/head-on mode, km (miles)	40/– (24.8/–)
Displays	PPI-70V HUD, ITO-1, ITO-2 tactical situation displays
Mainframe computer	A-15 (Argon-15)
Data link systems:	
air-to-ground	5U15K-11 'Raduga-Bort MB'
air-to-air	APD-518
ESM suite:	
radar homing and warning system	SPO-15LM 'Beryoza-LM'
chaff/flare dispenser	UV-3A (APP-50)



Yefim Gordon

◄

The retracted Model 8TP IRST pod under the nose. The pod swivels down and to starboard; the dielectric forward section is opaque and is made up of multiple sectors.

the on-board part of the AGCS, the IFF system (the IFF interrogator is part pf the WCS) and the air-to-air/air-to-ground data link system.

The target search/track sub-system comprises a radar channel (the Model 8B 'Leningrad' phased-array fire control radar), an infra-red channel (the Model 8TP IRST), a digital computing system built around the A-15 'Argon-15' mainframe computer, an indication system and control panels.

For the first time in the world, the long-range fire control radar forming part of the Zaslon WCS features a three-channel antenna system combining search, track and IFF channels; it is the Model B01 monobloc phased array with rapid electronic beam scanning. Another 'world first' in this class is the use of a narrow-band digital Doppler filter. The MiG-31 was the first Soviet fighter whose WCS featured pulse-Doppler signal processing, a tactical situation display and a digital processor.

Radar operation is enabled by the A-15 (Argon-15) digital mainframe computer which also controls other functions of the WCS. Together with the enhanced input/output devices, the mainframe computer forms the on-board digital data processing system (DDPS). This performs all operations associated with the radar channel of the WCS and all operations associated with computation and precision guidance.

With each movement of the radar beam the DDPS controls the phased antenna array, sets up the radar receiver strobes, forms the frequency grid for a spectrum analysis of the received signal and performs secondary data processing. It also harmonises the operation of the radar's modules and is linked to the Model 8TP infra-red search & track (IRST) unit.

The DDPS downloads target data to the missiles' seeker heads, controls the fighter in automatic control mode, enables concerted action by a group of fighters and displays flight/targeting and tactical information on the displays of the cockpit indication system.

The software can be upgraded rapidly by re-recording the RAM magnetic rings (discs). Parallel and serial data ports are provided.

The cockpit indication system comprises a PPI-70V head-up display (*pilo**tazh**no-pritsel'nyy indi**kah**tor* – flight/sighting display) and a small ITO-1 tactical situation display (*indi**kah**tor tak**tich**eskoy obsta**nov**ki*) in the pilot's cockpit, a larger ITO-2 tactical situation display in the WSO's cockpit, a dual radar/IRST channel display, an interface module and a power unit.

The PPI-70V HUD shows alphanumeric and graphic information on a cathode-ray tube (CRT); the image is then transferred to a semi-transparent reflector via a collimating system. The high-power projection tube obviates the need for a rubber sunblind even in backlight conditions. The ITO-1 and ITO-2 tactical situation displays are rapid-action direct vision CRT displays utilising alphanumeric and graphic formats. Besides being much smaller, the ITO-1 differs in displaying fewer information parameters and having a brightness enhancement feature with a light sensor to guarantee readability in the forward cockpit which has a much greater glazing area and is not shaded. The tactical situation displays utilise special cathode-ray tubes with an optical window allowing the screen image to be photographed from the inside without hampering observation. In the course of an upgrade new vibration-resistant colour CRT displays giving a clear picture even in backlight conditions were fitted.

The WSO's cockpit features a dual radar/IRST channel display whose electronic beam control units are directly connected to the output channels of the radar and IRST respectively. The repetition frequency is 50 Hz, which makes for normal data perception.

The interface module connects the HUD and tactical situation displays to the WCS's data bus; it also records, stores and regenerates the images on the displays with a preset afterglow imitation time.

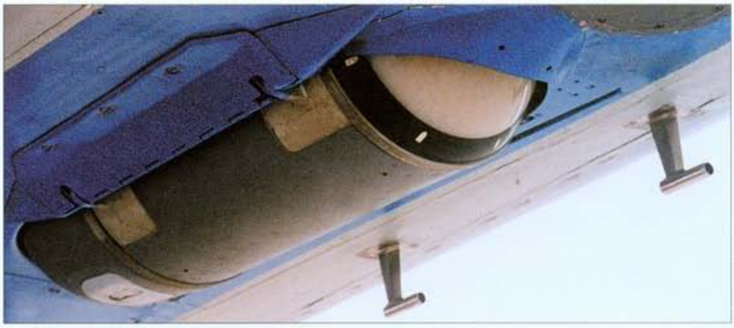
The Model 8TP infra-red search & track (IRST) unit is installed in a cylindrical pod normally stowed in the forward fuselage underside, swinging out only when in use. It is linked with the radar and enables the aircraft to make covert scanning of the forward hemisphere and covert attacks (that is, without revealing its position by using radar), providing target

Main Specifications of the Model 8B 'Leningrad' Fire Control Radar

Scan angle in elevation/azimuth:	
in 5.5 seconds	5°/45°
in 8.7 seconds	20°/90°
Field-of-view centre travel limits	±35°
Tracking area – half-cone with an angle of:	
upper hemisphere	140°
lower hemisphere	130°
Beam movement time to any position, ms	~ 1.3
Dynamic range of the receiver, dB	80
Width of the antenna's scatter pattern	2.5°
Mean power output of the radar transmitter, kW	2.5
Power output of the target illumination channel transmitter in constant emission mode, kW	2.0
Reception coefficient, dB	5.5
Antenna diameter	1.1 m (3 ft $7^{5}/_{16}$ in)
Power consumption, kW:	
200 V/400 Hz AC	31
27 V DC	2

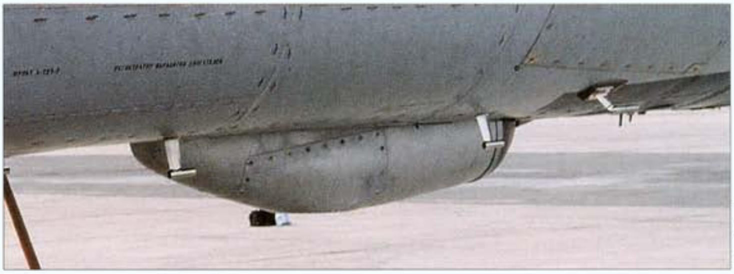
Main Specifications of the A-15 (Argon-15) Mainframe Computer

Efficiency, operations per second	~ 100,000
Random access memory (RAM) capacity, kb	4
Read-only memory (ROM) capacity, kb	72
Power consumption, W	250
Mean time between failures (MTBF), hours	500
Weight, kg (lb)	53 (116.8)



Yefim Gordon

Another view of the Model 8TP IRST on one of the company-owned demonstrators ('374 White' or '903 White'), showing the shape of the pod.



Yefim Gordon

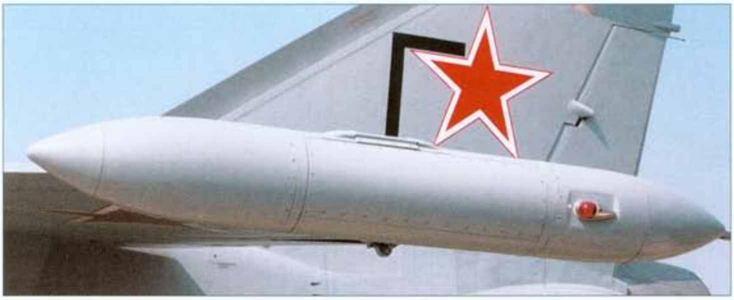
The IRST pod of the MiG-31M (in this case, '056 Blue') has a more elongated tail and protrudes more into the slipstream when stowed.

Main Specifications of the Model 8TP IRST

Scan angle in azimuth/elevation:	
in azimuth	120°
in elevation	40°
Tracking area:	
upper hemisphere	140°
lower hemisphere	130°
Resolution, minutes	15
Power consumption, kW	1.3
Mean time between failures (MTBF), hours	350
Weight, kg (lb)	124 (273)

information for the R-40TD and R-60M IR-homing missiles. It also enhances the aircraft's capabilities in an ECM environment. The IRST unit's field of view is ±60° in azimuth and +6°/–13° in elevation. Depending on the WCS's mode of operation, a large or small field of view is formed within these limits; its centre is determined by the radar, the AGCS or the WSO who moves the field-of-view centre marker on the display by means of a mini-joystick. If the radar is selected as the primary source of target data, the WCS gives the IRST target directions ('where to look'), using the radar tracking data; the field of view is ±3° x ±3° with respect to the target viewing line. An identical small field of view is formed similarly if the IRST is selected as the primary source of target data and the target is selected manually by the WSO.

One of the two camera pods at the wingtips of the MiG-31LL ejection seat testbed. The camera window is visible in the middle; the navigation light is positioned well aft. ▼▼



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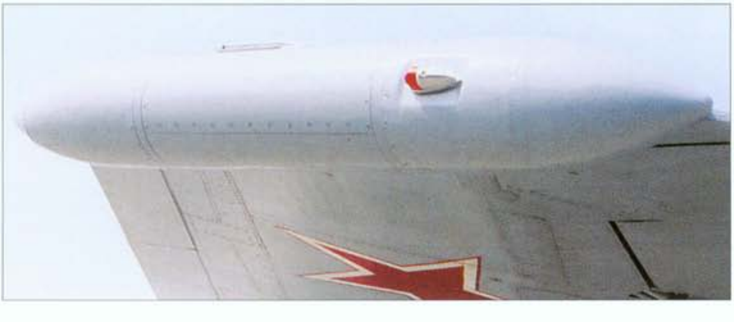

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If a target is designated for attack, the IRST locks on to the target which is nearest to the centre of the small field of view and automatically tracks it, feeding information on its viewing angle to the WCS. The average detection range in pursuit mode against a fighter-type target with the engines at full military power is about 40 km (24.8 miles).

The communication and monitoring module of the WCS generates the necessary commands in accordance with the missile launch preparation sequence. The actual launch preparations and launch are carried out by the weapons selector subsystem (WSS) which includes a logical/automatic control module, a stores indicator panel, a missile selector (arming) panel and a ground weapons preparation panel. The WSS supplies the WCS with information on the type, location and quantity of weapons carried, enables pre-setting of the weapons use modes on the ground (with the option of selecting between these modes in flight), indicates the selected weapons' status and remaining quantity, and automatically activates another missile if an armed missile of the same type fails to leave its launch rail for some reason. The missiles are selected by the WSO by flipping the appropriate arming switches on the weapons selector panel and fired by the pilot in beyond visual range (BVR) mode by pushing the 'fire' button on the control stick. There is also a switch in the forward cockpit enabling the pilot to use the 'fire' button for attacking targets which are within visual range.

The WSS communicates with the WCS via digital information exchange channels. Its specialised digital processor handles missile arming and launch tasks.

The MiG-31B and MiG-31BS have an upgraded RP-31A (S-800A) Zaslon-A weapons control system. The MiG-31M has an RP-31M (S-800M) Zaslon-M WCS.

Flight and navigation avionics: The flight and navigation suite includes the SAU-155MP automatic flight control system (or SAU-155MP-03, depending on the version) with the SOS-3M-2 flight mode limit indication system (*sis**tem**a ograni**chi**tel'noy signali**zah**-tsii*) and the KN-25 navigation suite. The latter enables the MiG-31 to operate in the Arctic regions lacking ground navigation aids; it comprises:

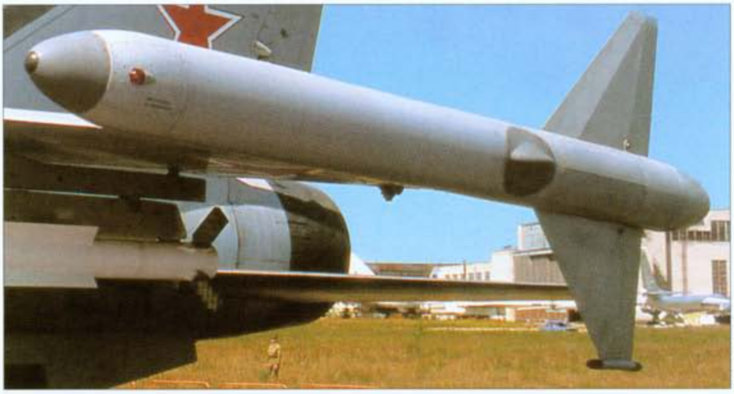
- a duplicated IS-1-72A inertial navigation system (INS);
- a *Ma**nyovr**-V* (Manoeuvre-V) digital processor;

- an A-312-10 *Radi**kal**-NP* or a A-331 SHORAN system;
- an A-723 *Kvi**tok-2*** (Receipt-2) LORAN system (installed from the outset on MiG-31 c/n N38400171519 and from c/n N38400181345 onwards and retrofitted to MiG-31s *sans suffixe* being upgraded to MiG-31BS standard);
- an SVS-2Ts-1 air data system (*sis**tem**a vozd**oosh**nykh sig**nah**lov*);
- a BSFK-2 combat heading setter system (*boye**va**ya sis**tem**a formiro**va**niya **koor**sa*);
- an A-312-09 Radikal-OVK relative position determination (RPD)/formation-keeping system (OVK = *oprede**len**iye vza**im**nykh ko'ordi**naht*** – mutual co-ordinate determination);
- a Tropik LORAN system with an error margin of 0.13-1.3km (0.08-0.8 miles) over a 2,000-km (1-240-mile) stage;
- a *Mars**hroot*** (Route) LORAN system with an error margin of 1.8-3.6km (1.1-2.2 miles) over a 2,000 to 10,000-km (1,240 to 6,210-mile) stage;
- a PA-4-3 automatic moving map display (MMD; PA = *plan**shet** avtoma**tich**ecskiy*);
- a BK-43 interface module (*blok kommuni**kah**tsii*);
- PKN-1 and PKN-2 navigation suite control keypads.

The flight and navigation avionics suite also includes an ARK-19 automatic direction finder, an RV-15 (A-031) radio altimeter and an A-611 marker beacon receiver (with options for installing the MRP-61 or the older MRP-56 marker beacon receiver) instead.

Communications suite: The MiG-31 *sans suffixe* (*izdeliye* 01 and *izdeliye* 01DZ) are fitted with the following communications equipment:

- an 11B6 (5U15K-11 ***Ra**duga-Bort-MB*) or 11G6 Spektr ground-controlled intercept command link system;
- an APD-518 secure data link/tactical information exchange system;
- an RK-RLDN secure digital data link system;
- an R-862 UHF radio;
- an R-864 HF radio;
- an R-855UM radio;
- an SPU-9 intercom;
- a *Po**tok**-NKR* (Stream-NKR) antenna-feeder system;
- a P-591 audio (speech) warning device indicating dangerous flight modes and critical failures.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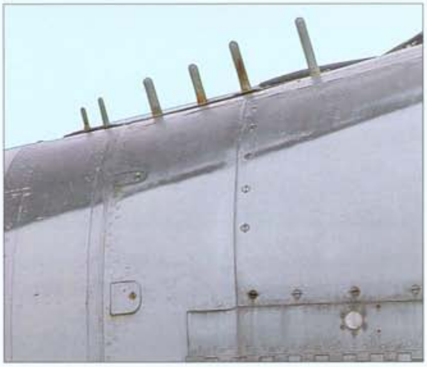
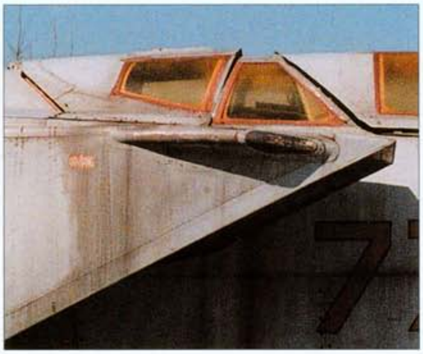
▲
The port wingtip ECM pod of MiG-31M '057 Blue'. The forward and aft extremities are dielectric, and a third antenna is positioned amidships to give full 360° ECM coverage. Note the forward position of the navigation light.



◄
The multiple rod aerials of the IFF system ahead of the cockpit windshield.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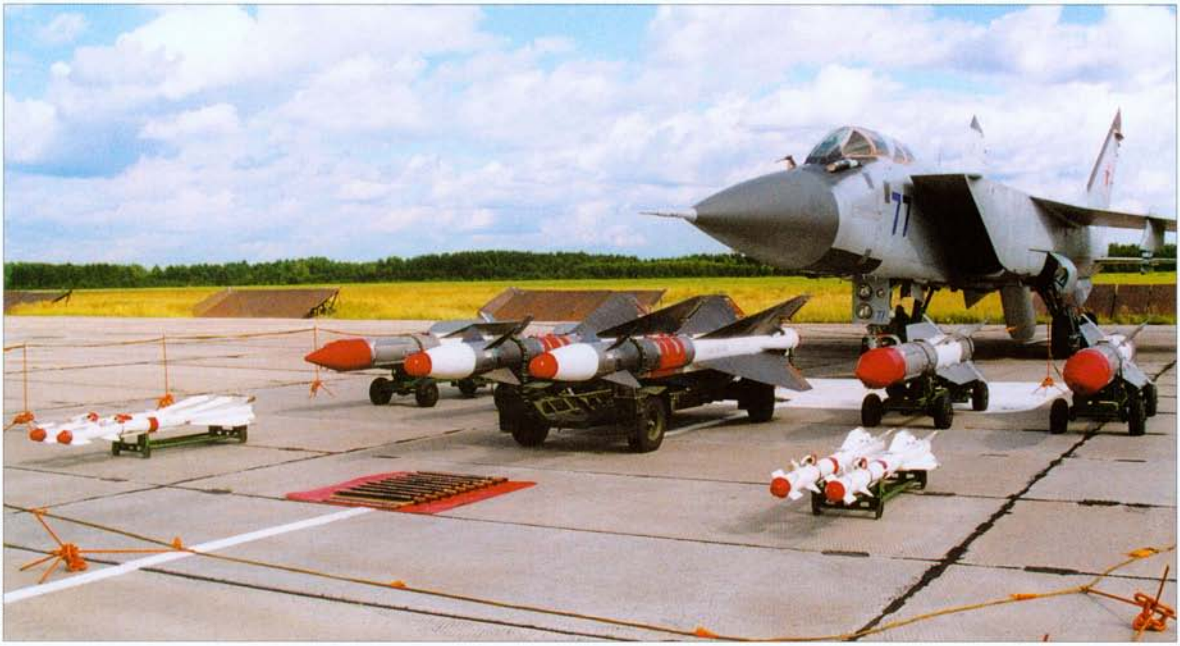
The front ends of the air intake trunks of the 'first-generation' MiG-31 carry ECM antennas covering the forward hemisphere.
▼◄

The forward portions of the ventral fins house some of antennas serving the communications suite.
▼



Vyacheslav Martyniuk

▲
The MiG-31B's weapons arsenal arrayed in front of it. Front row: four R-60M short-range IR-homing AAMs, with 30-mm ammunition for the GSh-6-30 cannon in the middle. Rear row: two R-40TD medium-ran ge IR-homing AAMs on a common ground handling dolly, flanked by four R-33 long-range radar-homing AAMs on individual dollies. All missiles have protective covers over the seeker heads and proximity fuse aerials.

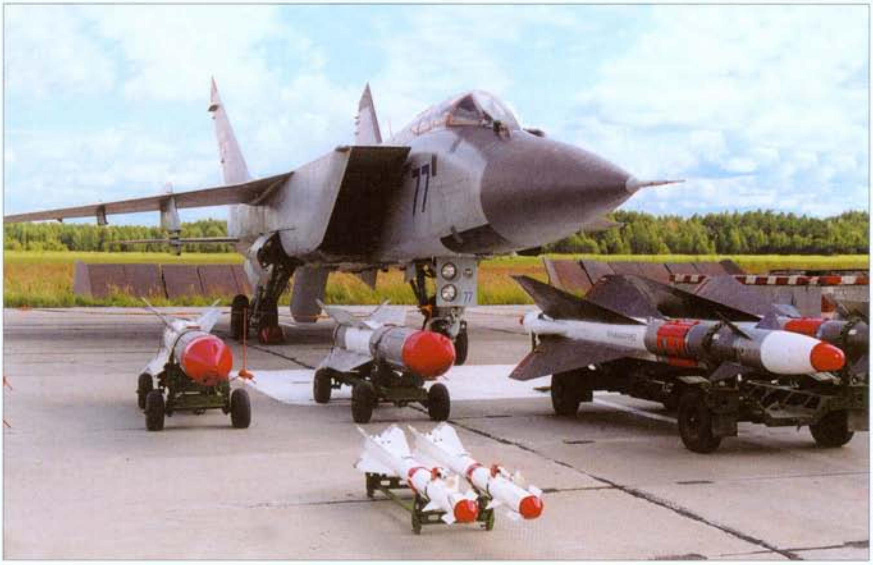
ESM equipment: SPO-15LM Beryoza-LM radar homing and warning system (RHAWS).

IFF equipment: SRO-2P (*izdeliye* 6202) IFF transponder and, depending on the version, SRZ-2P (*izdeliye* 6232), SRZ-2P3 or SRZ-035M (*izdeliye* 035M) IFF interrogator; the latter model was fitted from the spring of 1991 onwards. An SO-69 ATC receiver is also fitted.

Data recording equipment: RIU registering/indication device, Tester-UZL flight data recorder and MS-61 cockpit voice recorder.

The RK-RLDN secure digital data link system (***rah****dioko****mahnd****naya* ***lin****iya* ***dahl'****nevo nave****den****iya* – long-range radio command guidance line) serves for interaction with ground command posts.

MiG-31s *sans suffixe* (*izdeliye* 01) up to and including Batch 81 were manufactured



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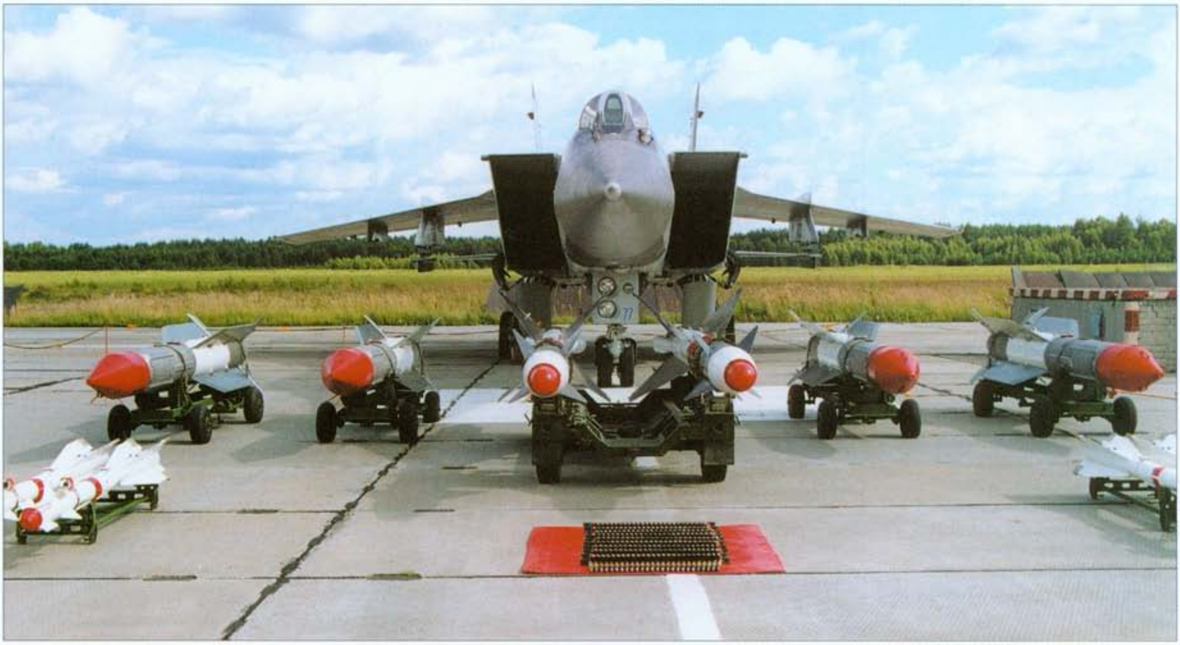
Another view of the weapons array in front of MiG-31B '77 Blue' at Savasleyka AB. The bulk of the interceptor's main weapons is clearly illustrated.



Vyacheslav Martyniuk

▲
One more view of the *Foxhound*'s weapons. The 44-kg (97-lb) R-60Ms can be hooked up manually, while the other missiles obviously require powered lifts (the R-33, for instance, weighs 520 kg/1,150 lb).

with the 11B6 Raduga-Bort-MB (Rainbow-Aircraft-MB, alias 5U15K-11) GCI command link system and the APD-518 secure data link system enabling aircraft in a flight to swap target data generated by their WCS. From Batch 82 onwards (*izdeliye* 01DZ) the 11G6 Spektr (Spectrum) GCI command link system was fitted instead; it was also retrofitted during upgrade to MiG-31BS standard. The command link system serves for receiving and decoding queries from the automated ground-based IFF system, receiving information on the target(s) and the interceptor and targeting/guidance commands from AGCS stations, and decoding the received information for the on-board data processing and presentation systems. The data received by the 5U15K-11 (Raduga-Bort-MB) system is fed into the SAU-155MP automatic flight control system, the A-15 Argon-15 digital mainframe computer and the PPI-70V HUD.

The system works with the *Roo***bezh***-M* (Frontier-M), Looch-2 (Ray-2, or Beam-2) and ***Voz****dookh-1M* (Air-1M) automatic GCI systems featuring *La***zoor***'-M* (Prussian Blue-M) and Raduga-SPK data link systems. The information is received by the command link system as sets of codes containing targeting/guidance data, single commands and target co-ordinate support for semi-autonomous operation. The information is fed into the RP-31 Zaslon WCS as a digital serial code, analogue signals and single commands. The command link system comprises a receiver, a decoder, an interface and a control panel.

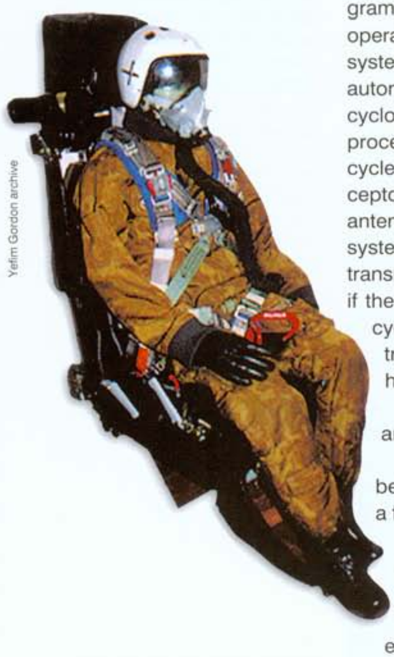
The APD-518 digital secure data link enables a flight of four MiG-31s to swap data generated by their weapons control systems if the aircraft are within 200 km (124 miles) of each other. It also enables other aircraft with less sophisticated avionics, such as the MiG-25, to be directed to targets spotted by the MiG-31, in which case the latter acts as a 'mini-AWACS'. The system comprises an input module/encoder, a decoder/output module, a control panel and the A-312-10 Radikal-NP SHORAN system.

The APD-518 can relay information from the flight leader to his wingmen and back, from the leader of a group to the leader of another group and from the leader of a group to a ground command post. The information is relayed via the SHORAN system; the digital data processing system of the WCS acts as the source and the recipient of the data. The APD-518 has no control panel of its own, receiving commands from the control panels of the RP-31 Zaslon WCS and the A-312-09 Radikal-OVK relative position determination/formation-keeping system. The control module generates the signals controlling the data input/output and transmission processes and the self-test and monitoring function.

Main Specifications of the MiG-31 (Izdeliye 01/01DZ), MiG-31B and MiG-31BS

Length, including nose probe	22.668 m (74 ft 5 in)
Wing span	13.456 m (44 ft 2½ in) *
Horizontal tail span	8.74 m (28 ft 8 in)
Height on ground	5.15 m (16 ft 10½ in) †
Wing area, m² (sq ft):	
including centre section/excluding LERXes	61.6 (663)
excluding centre section	41.0 (441)
Empty weight, kg (lb)	21,820 (48,100)
Take-off weight, kg (lb):	
with max fuel/no external stores	36,700 (80,910)
normal (with four R-33 missiles and normal fuel, no drop tanks)	37,100 (81,790)
normal (with four R-33 missiles and max fuel, no drop tanks)	41,000 (90,390)
max (with four R-33 missiles, max fuel and two PTB-2500 drop tanks)	45,900-46,200 (101,190-101,850)
Landing weight, kg (lb)	26,600 (58,640)
Fuel capacity, litres (Imp gal):	
full, with/without drop tanks	23,500/18,500 (5,170/4,070)
normal	13,700 (3,014)
in drop tanks,	2 x 2,500 (2 x 550)
Fuel load, kg (lb):	
full,with drop tanks	20,550 (45,300)
full, no drop tanks	16,350 (36,045)
Thrust-to-weight ratio at normal take-off weight, kgp/kg (lbst/lb)	0.76

The Zvezda K-36DM Srs 2 zero-zero ejection seat with the characteristic 'rip yer balls off' ejection handles – a feature that minimises the time required to shift the pilot's hand from the stick or throttle to the handle. The cylinders flanking the headrest house telescopic stabilising booms with drogue parachutes. Note the seat harness and the cross on the dummy's helmet used for measurements during ejection trials. ▼



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The information exchange between interceptors takes place in accordance with cyclograms. Two modes are possible; in the joint operation mode the APD-518 and A-312-09 systems use a common cyclogram, while in autonomous mode the APD-518 uses its own cyclogram. In the former case the digital data processing system of the WCS uses the RPD cycle to determine on what side of the interceptor the receiver aircraft is and which antenna of the A-312-10 Radikal-NP SHORAN system (port or starboard) is to be used for transmission. The autonomous mode is used if the SHORAN system fails; in this case the cyclogram changes, as the system has to transmit the same information during two half-cycles to both port and starboard.

These four data exchange algorithms are possible:

- 'group' (information exchange between the flight leader and a wingman in a flight of three or four MiG-31s);
- 'pair exchange' (information exchange between the leader and the wingman in a pair of interceptors);
- 'leaders' exchange' (information exchange between the leaders of two or more different flights);
- 'solo' (periodic uploading of information from a solitary interceptor to the automated ground control system.

When two flight leaders communicate, their data exchange with their respective wingmen and the ACGS is interrupted.

The TKS-2 secure data link system ensures two-level tactical information exchange within a joint task force comprising up to four flights, each of which consists of four aircraft. The exchange between the leader of the joint task force and the flight leaders takes place at the higher level; the time separation principle is used and the system is tuned to inter-group exchange frequency. In turn, the flight leaders communicate with their respective wingmen at the lower level, using their own frequencies. The leader of the joint task force is also a flight leader, with three wingmen of his own.

The MiG-31 has a total of 67 antennas and aerials. The electric system features generators with a total output of 92 kW to cater for the varied electric and electronic equipment.

The MiG-31M differs significantly from the preceding versions in avionics fit; more up-to-date navigation and communications equipment is used, including satellite navigation systems.

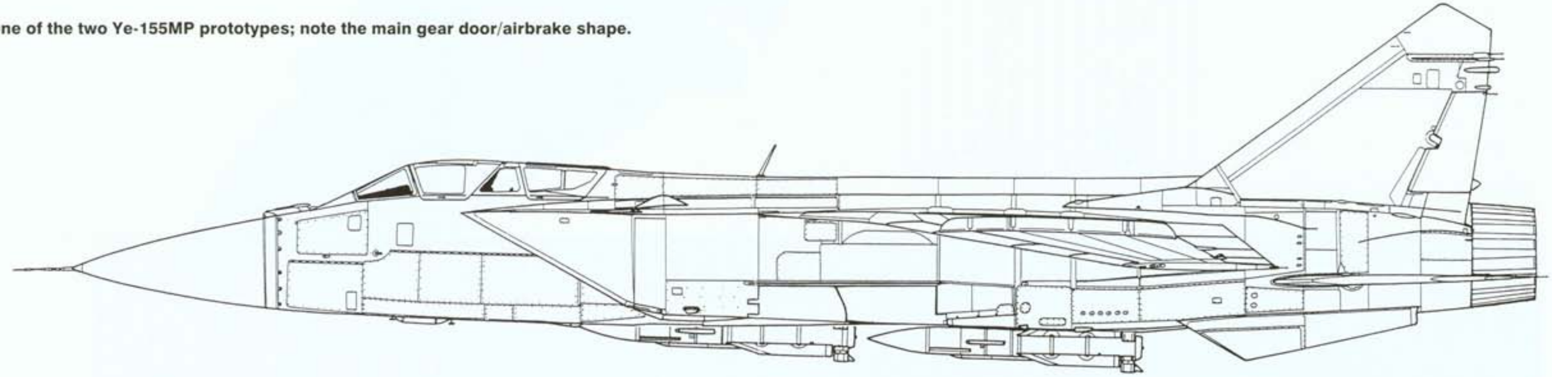
Crew Rescue System

All versions of the MiG-31 are equipped with Zvezda K-36DM Srs 2 zero-zero ejection seats. Early development aircraft had KM-1M seats with a limited operational envelope.

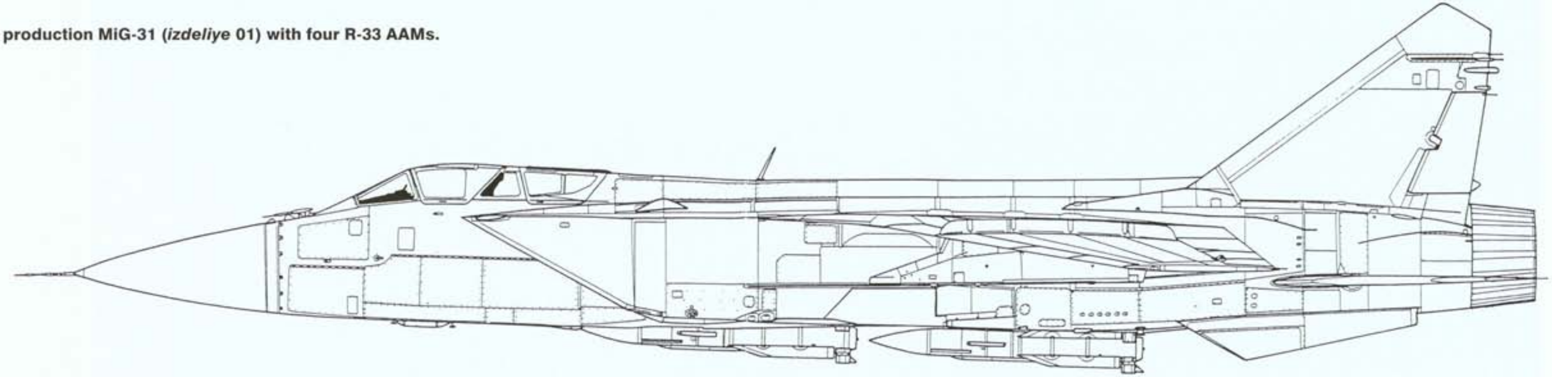
Wing loading at normal take-off weight, kg/m^2 (lb/sq ft)	666 (136)
Maximum speed, km/h (mph):	
at 17,000 m (55,770 ft) and above	3,000 (1,864)
at sea level	1,500 (932)
Max indicated airspeed with R-40TD and R-60 missiles, km/h (mph)	1,200 (745)
Max IAS with drop tanks at 10,000 m (32,810 ft)	Mach 0.9
Max IAS with deployed forward-vision periscope, km/h (mph)	700 (434)
Cruising speed, km/h (mph):	
supersonic	2,500 (1,553)
subsonic	900 (559)
Unstick speed, km/h (mph):	
with a 37,100-kg take-off weight	345 (214)
with a 41,000-kg take-off weight	365 (226)
Landing speed at a 26,600-kg landing weight, km/h (mph)	280-285 (173-177)
Maximum Mach number	2.83
Maximum Mach number with R-40TD missiles	2.35
Service ceiling with four R-33s and 2,300 kg (5,070 lb) of fuel remaining, m (ft)	20,600 (67,585)
Climb time to 19,000 m (62,335 ft) with four R-33s and normal fuel, minutes	7.9
Rate of climb, m/sec (ft/min):	
w. 31,000-kg (68,340-lb) TOW, 'clean', in full a/b at 2,000 m (6,560 ft)/Mach 0.9	174 (34,240)
w. 31,000-kg TOW, 'clean', at 15,000 m (49,210 ft) and Mach 2.35	140 (27,550)
w. 35,000-kg (77,160-lb) TOW, with missiles, at 15,000 m and Mach 2.35	115 (22,630)
Maximum range with four R-33 missiles, km (miles):	
at Mach 2.35	1,400 (869)
at Mach 0.8 without drop tanks	2,150-2,400 (1,335-1,491)
at Mach 0.8 with drop tanks	2,850-3,000 (1,770-1,864)
Ferry range, km (miles)	3,300 (2,050)
Intercept range, km (miles):	
supersonic	720 (447)
subsonic, no drop tanks	1,200 (745)
with drop tanks	1,400 (870)
with drop tanks and one refuelling ‡	2,000 (1,242)
Endurance:	
unrefuelled	3.6 hours
with one refuelling ‡	6-7 hours
G limit:	
with 6,000 kg (13,230 lb) of fuel or less	5.0
at Mach 0.8-1.5, no drop tanks	4.5
with drop tanks	2.5
Permissible flight time with R-60 missiles, minutes:	
at Mach 2.35	≤ 2
at Mach 2.2	≤ 8
at Mach 0.9 with drop tanks	≤ 60
Take-off run at 37,100 kg (81,790 lb) take-off weight, m (ft)	950 (3,120)
Landing run at 26,600 kg (58,641lb) and with brake parachutes deployed, m (ft)	800-900 (2,620-2,950)
Landing angle at 26,600 kg TOW	13°
Turn radius, m (ft):	
w. 34,000-kg (74,955-lb) AUW, in full a/b at 5,000 m (16,400 ft) and Mach 0.8	2,900 (9,510)
w. 34,000-kg AUW, at 1,000 m (3,280 ft) and Mach 0.67	1,200 (3,940)
Altitude gain in a 'yo-yo' manoeuvre initiated at 500-1,000 m, m (ft)	5,000-8,000 (16,400-26,250)
Maximum dive angle	45°

* Different manuals state a different figure – 13.464 m; † A Mikoyan brochure states 6.15 m (20 ft 2⅛ in);

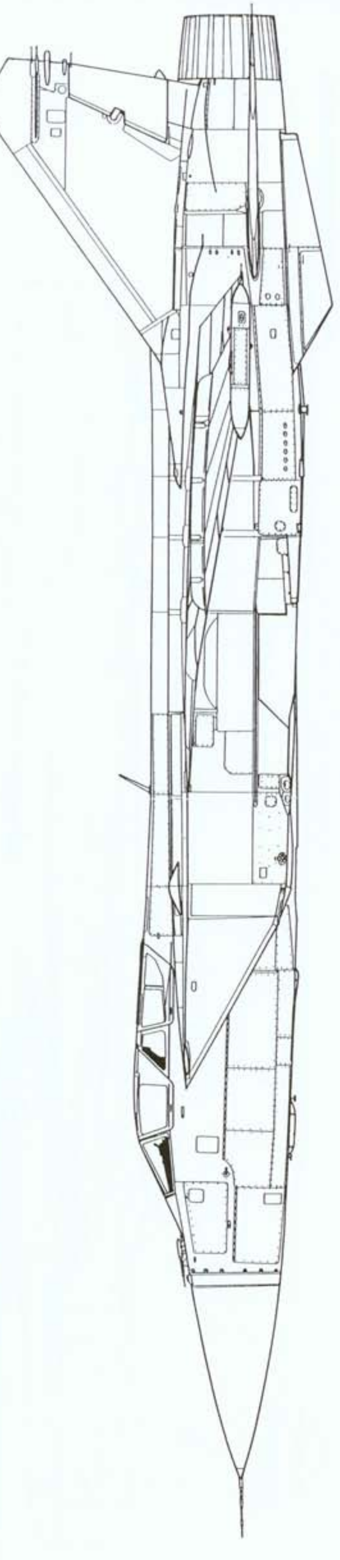
‡ MiG-31 (*izdeliye* 01DZ) and MiG-31B



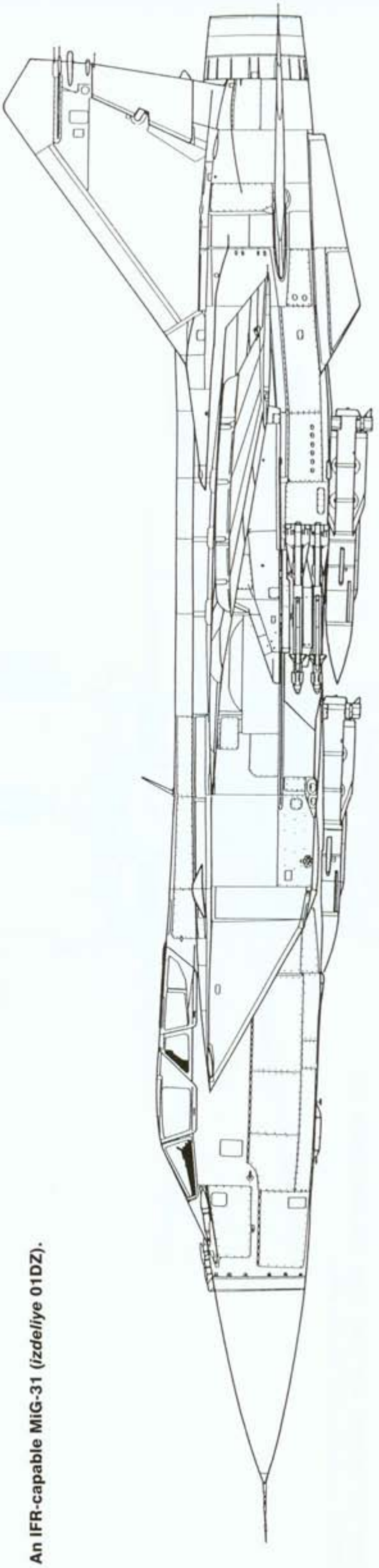
One of the two Ye-155MP prototypes; note the main gear door/airbrake shape.



A production MiG-31 (*izdeliye* 01) with four R-33 AAMs.

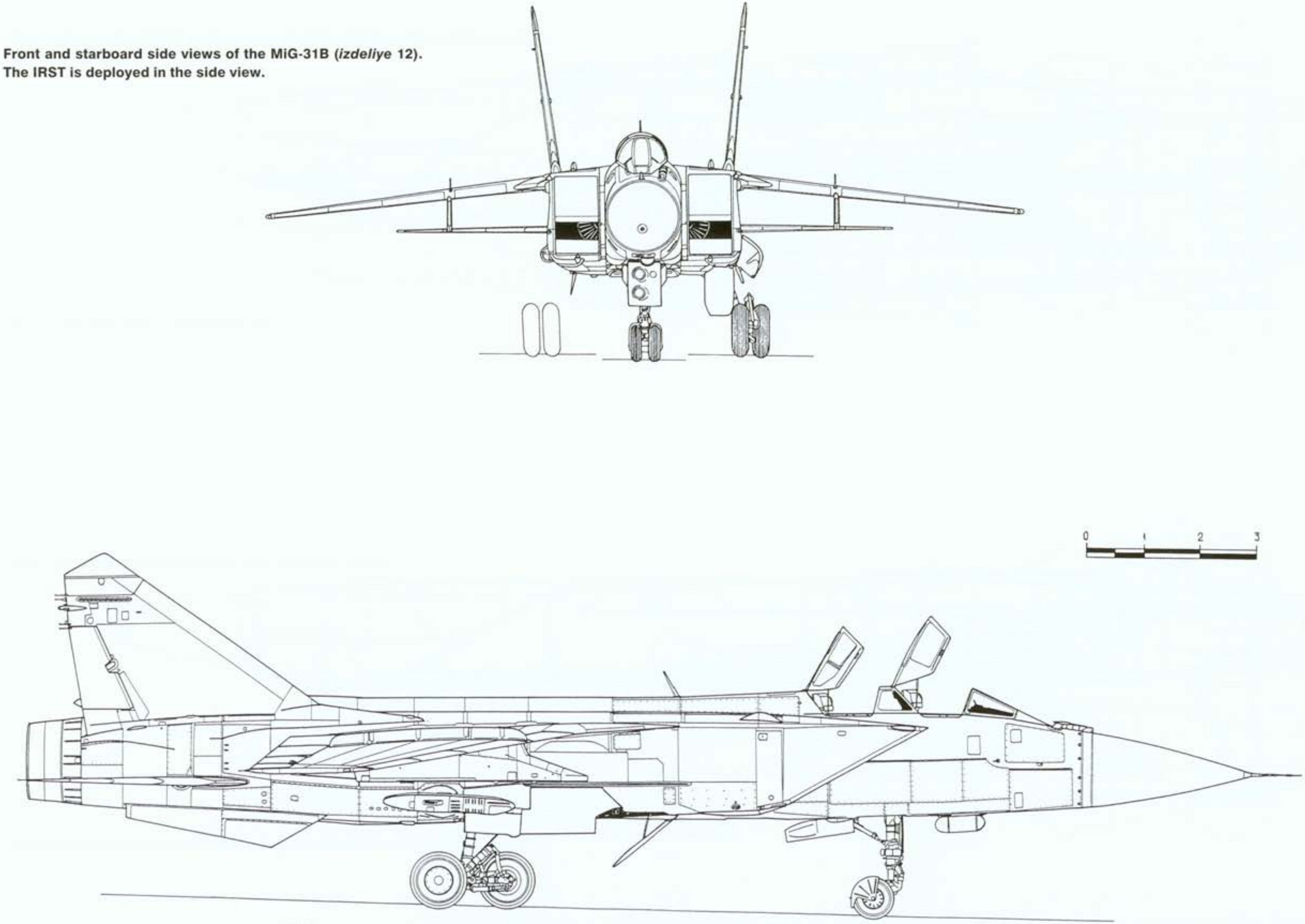


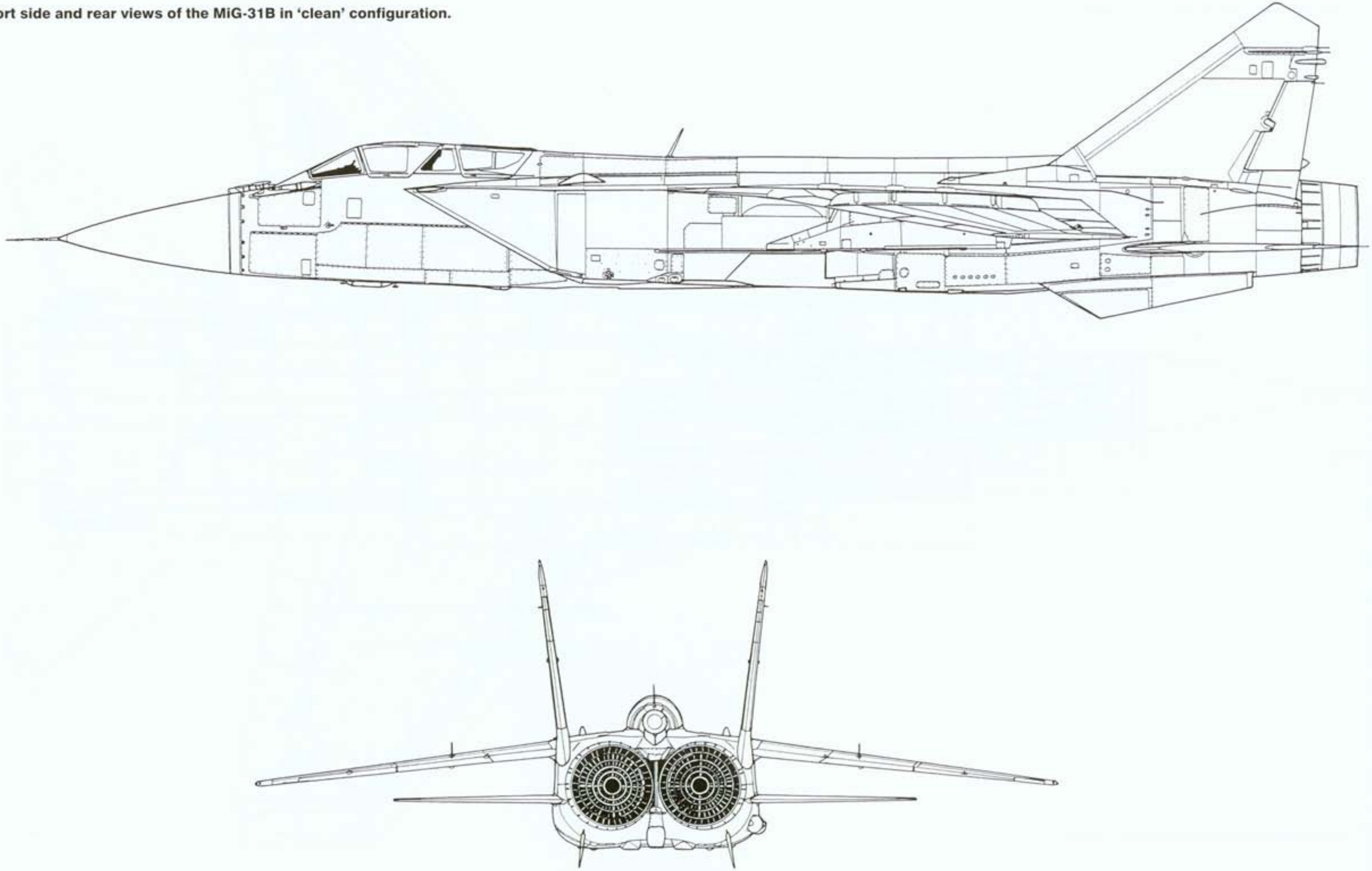
The MiG-31LL ejection seat testbed ('79 Red') with the rear canopy in place.



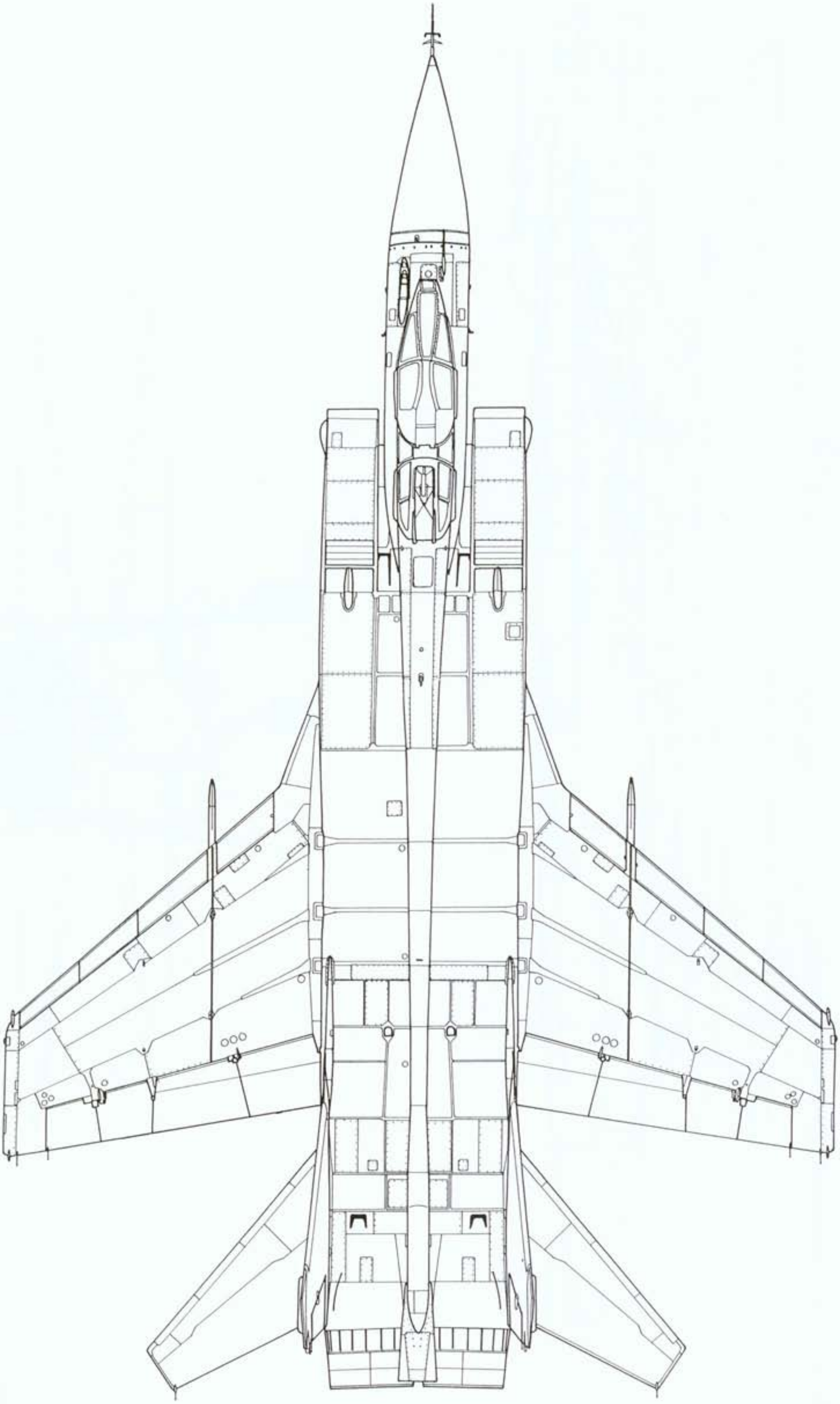
An IFR-capable MiG-31 (*izdeliye* 01DZ).

Front and starboard side views of the MiG-31B (*izdeliye* 12).
The IRST is deployed in the side view.

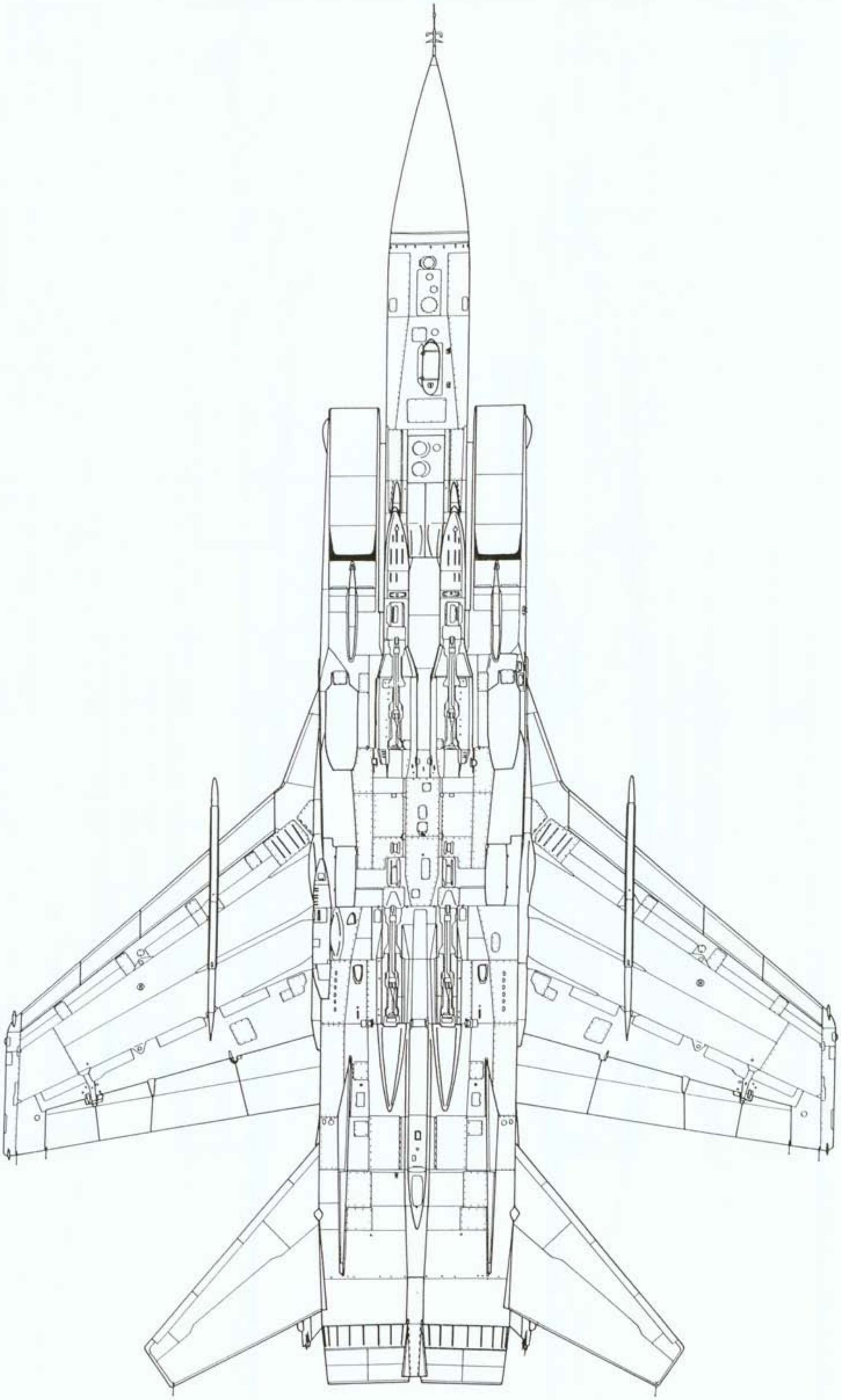




Port side and rear views of the MiG-31B in 'clean' configuration.

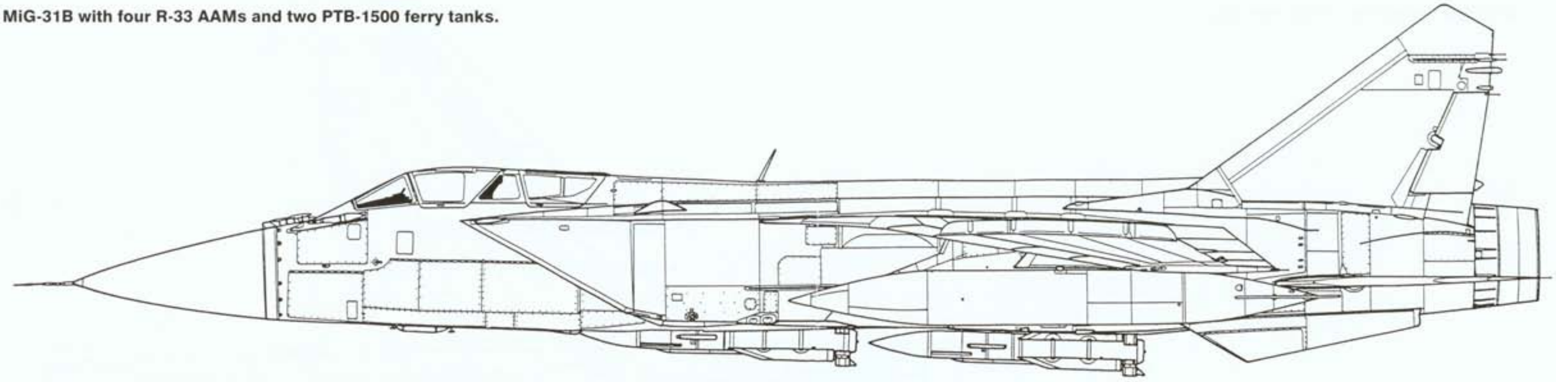


Upper view of the production MiG-31B.

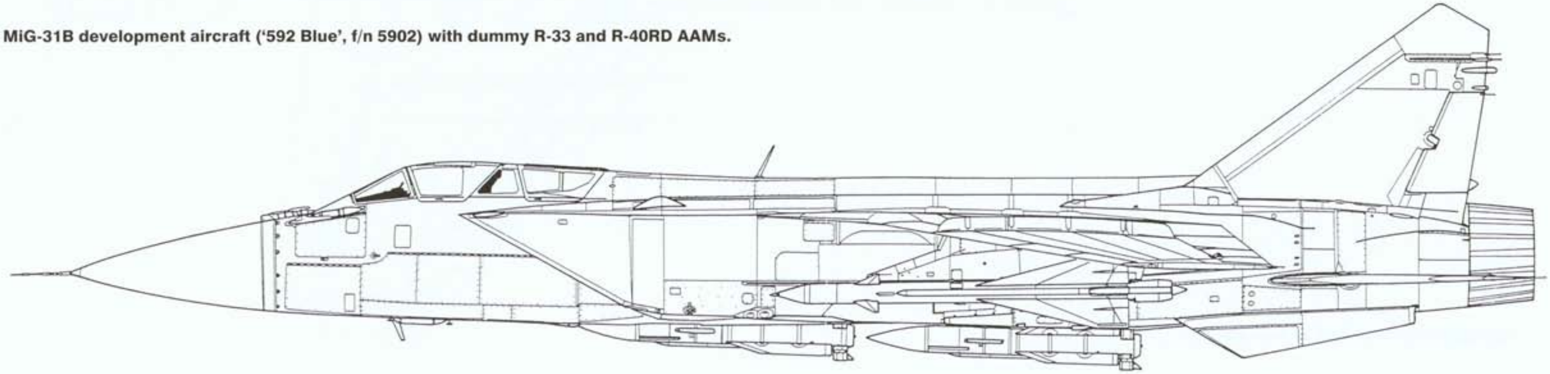


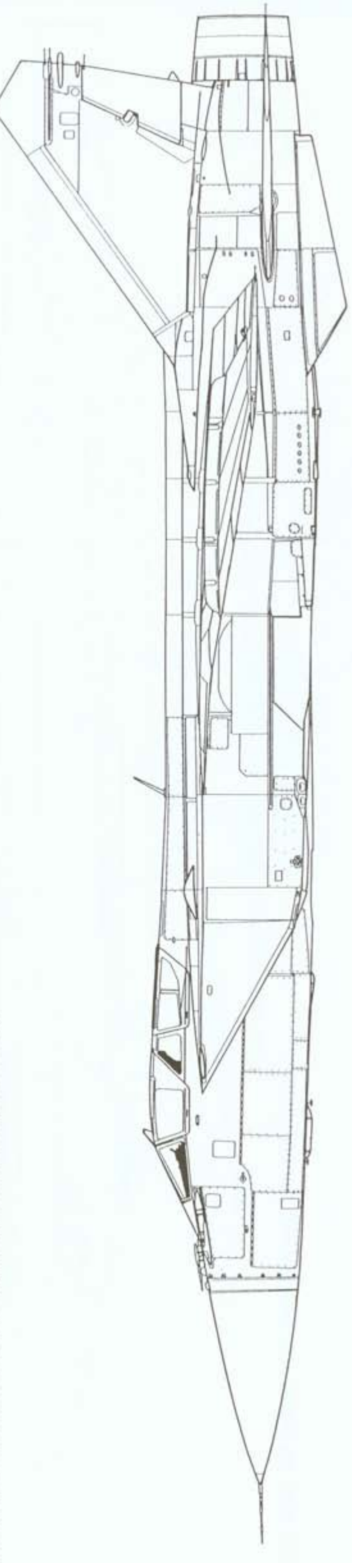
Lower view of the production MiG-31B.

A MiG-31B with four R-33 AAMs and two PTB-1500 ferry tanks.

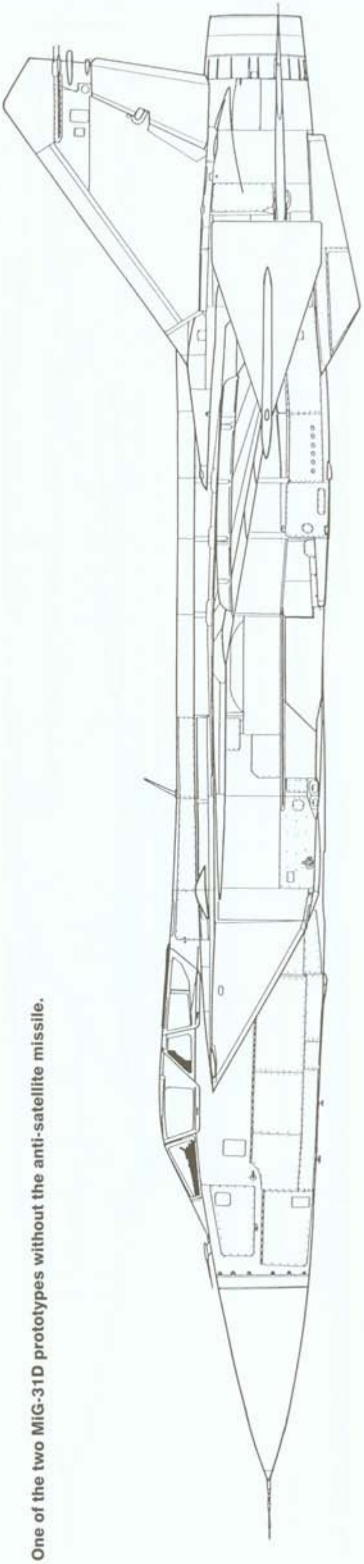


A MiG-31B development aircraft ('592 Blue', f/n 5902) with dummy R-33 and R-40RD AAMs.

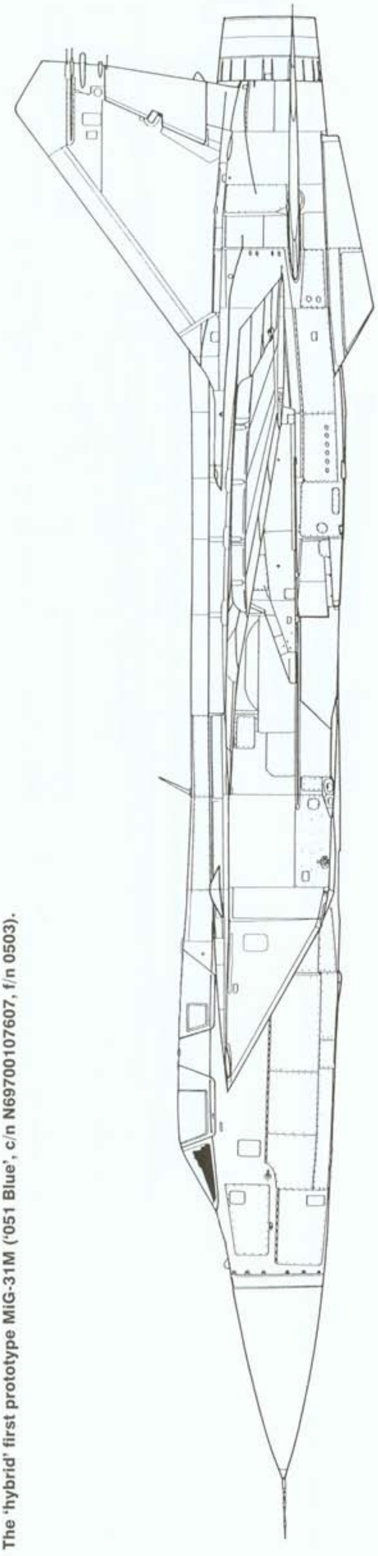




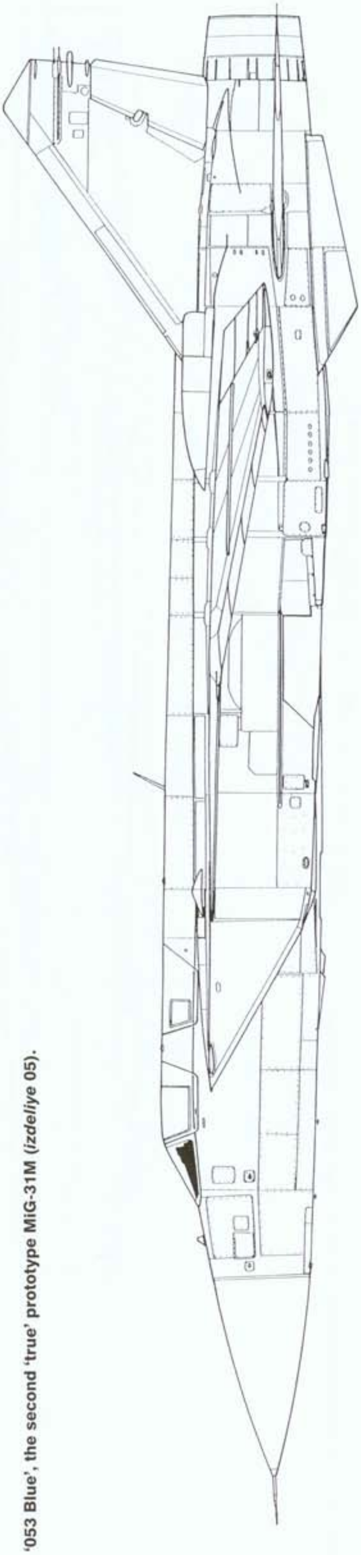
The MiG-31 demonstrator owned by the Mikoyan OKB ('374 White').



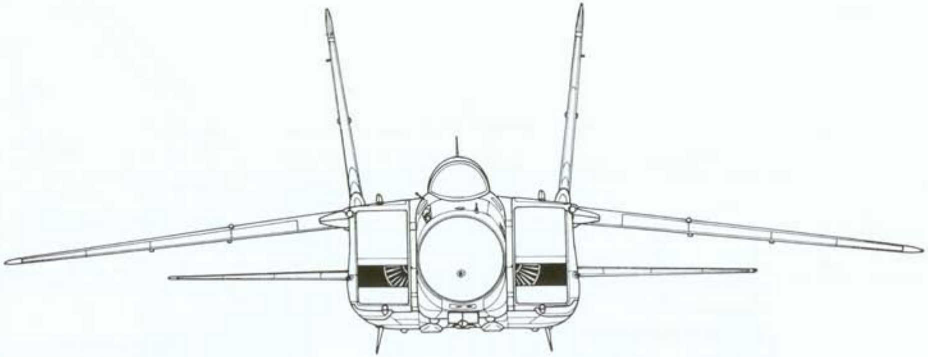
One of the two MiG-31D prototypes without the anti-satellite missile.



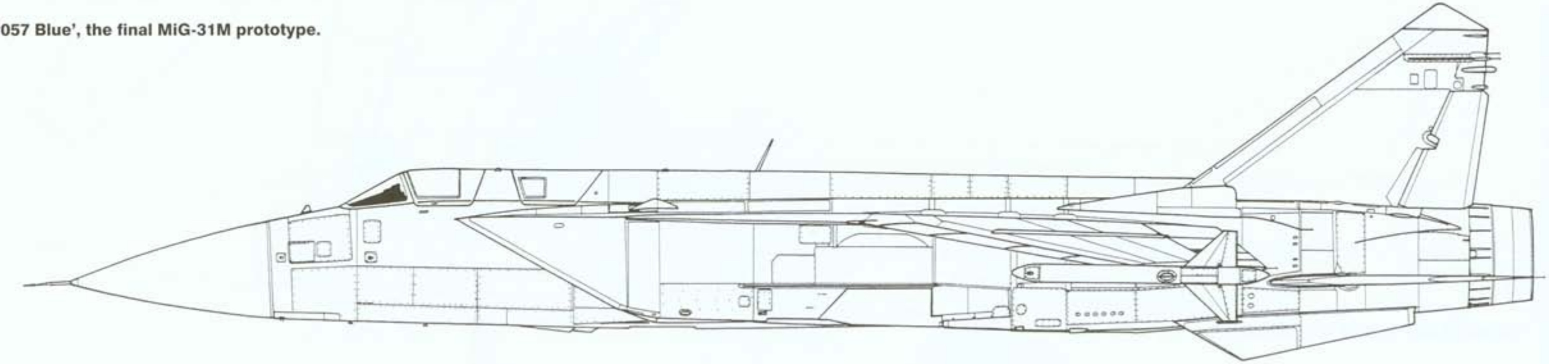
The 'hybrid' first prototype MiG-31M ('051 Blue', c/n N69700107607, f/n 0503).



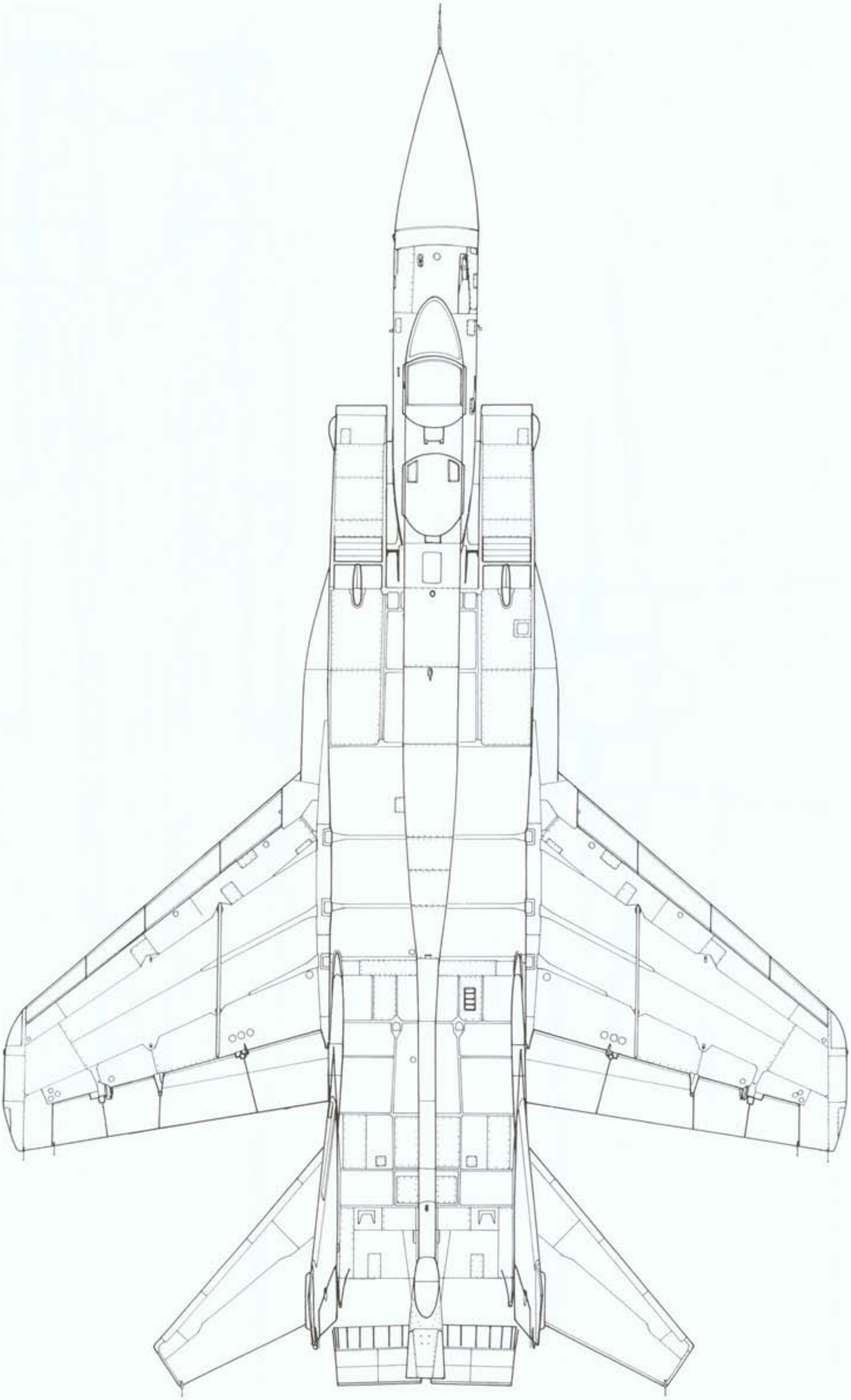
'053 Blue', the second 'true' prototype MiG-31M (*izdeliye* 05).



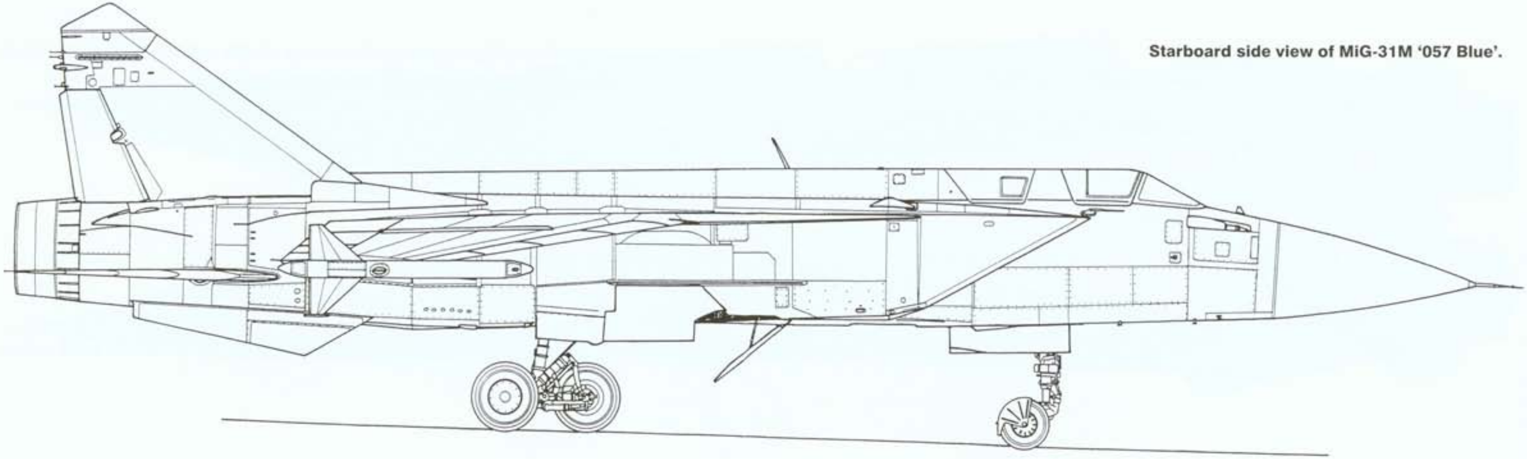
Front view of MiG-31M '053 Blue'.



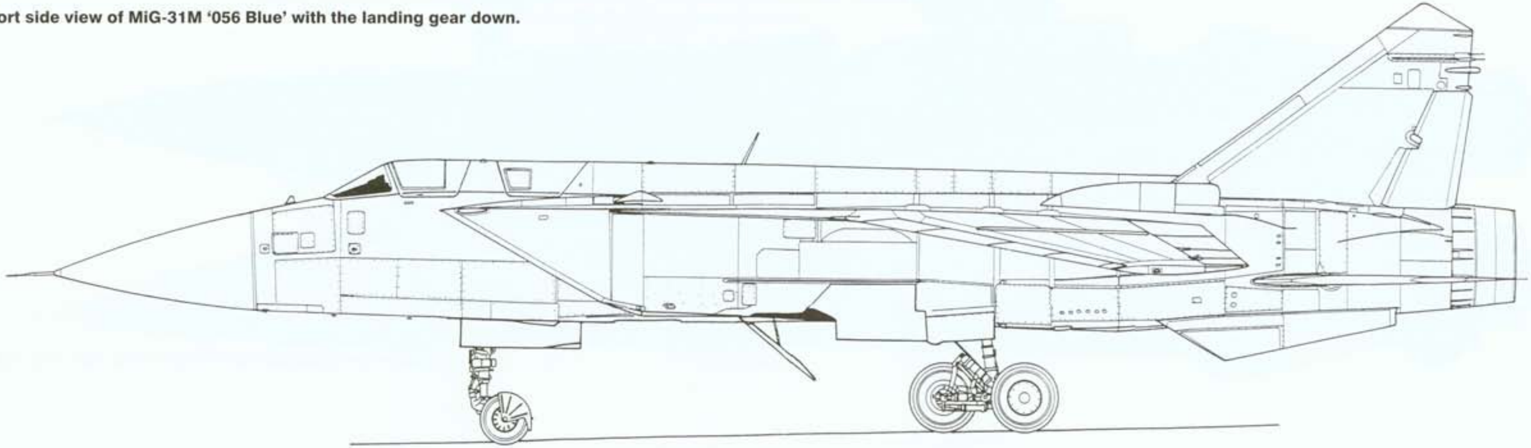
'057 Blue', the final MiG-31M prototype.



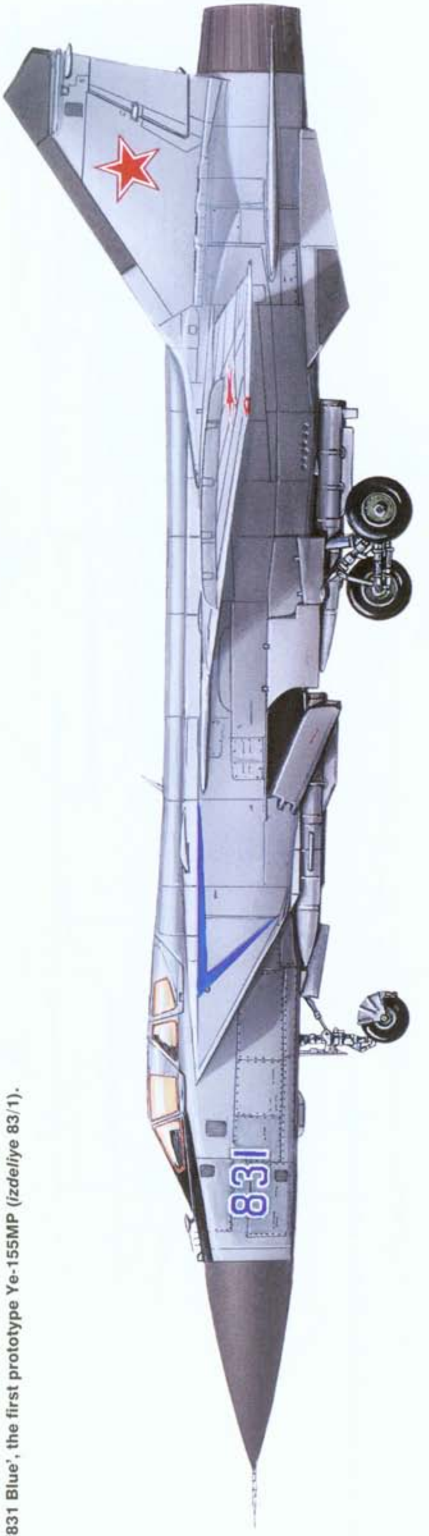
Upper view of MiG-31M '053 Blue'.



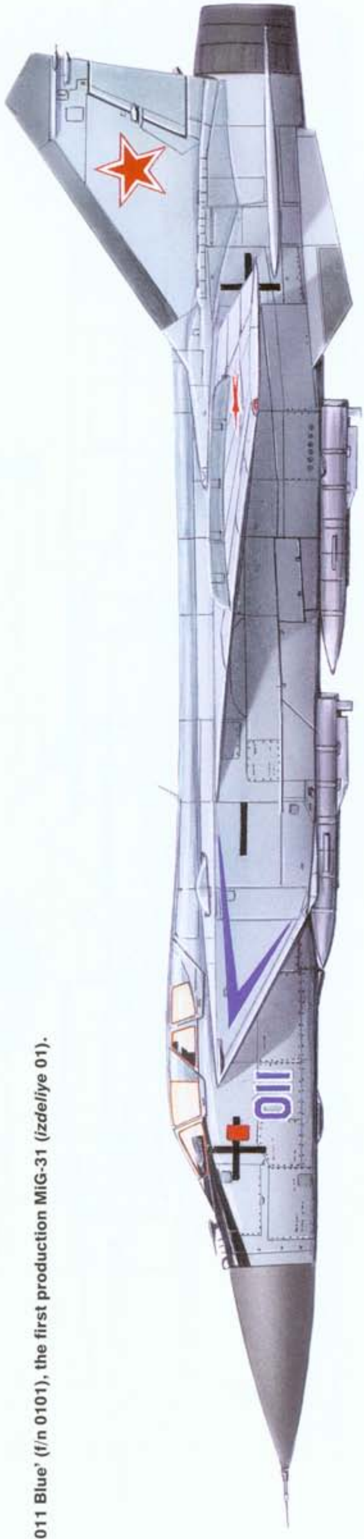
Starboard side view of MiG-31M '057 Blue'.



Port side view of MiG-31M '056 Blue' with the landing gear down.

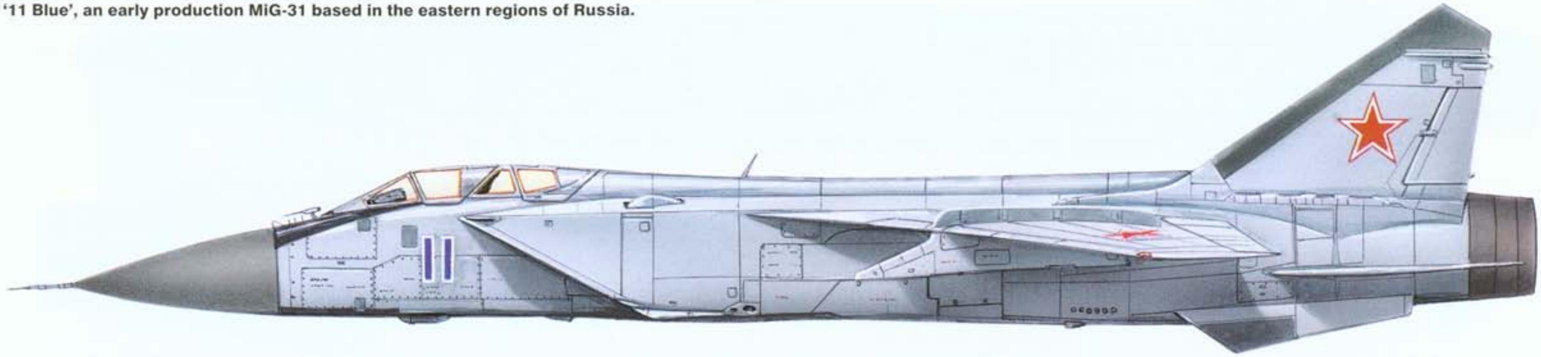


'831 Blue', the first prototype Ye-155MP (*izdeliye* 83/1).

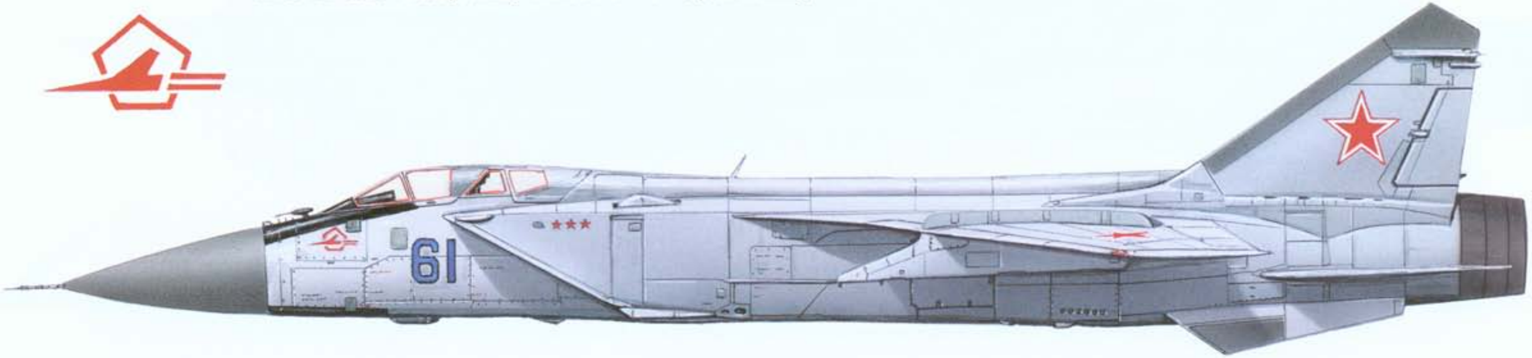


'011 Blue' (f/n 0101), the first production MiG-31 (*izdeliye* 01).

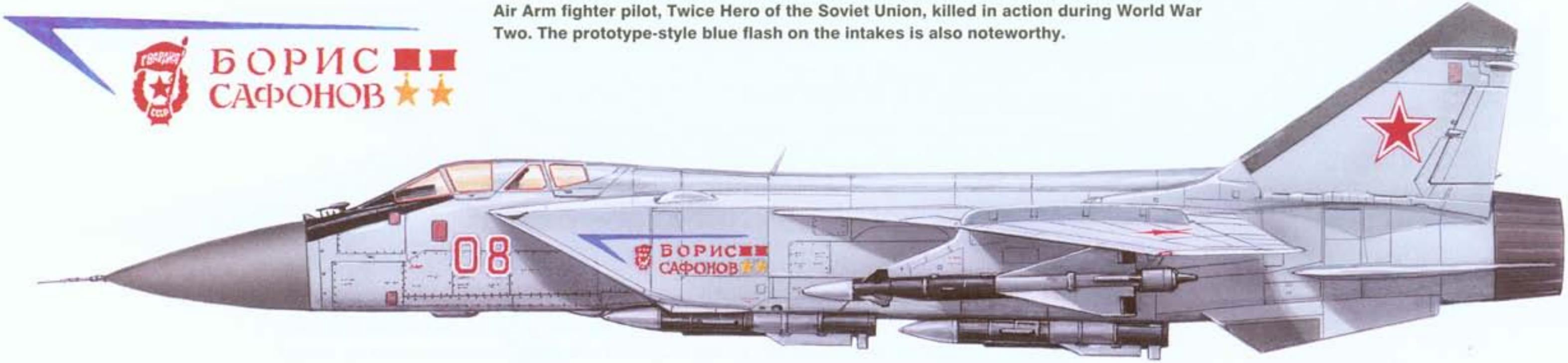
'11 Blue', an early production MiG-31 based in the eastern regions of Russia.



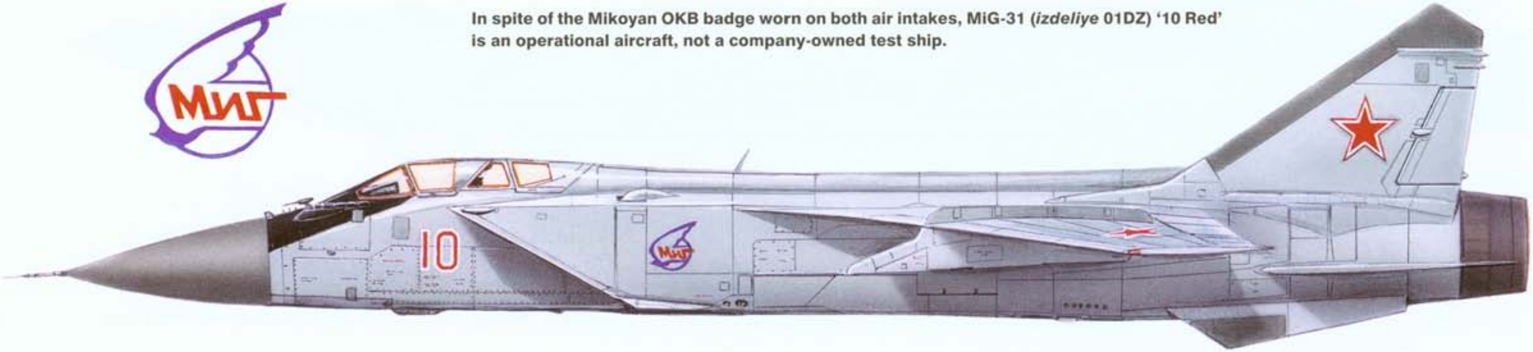
MiG-31 '61 Blue' carries the 'Excellent aircraft' badge (a maintenance award) and three 'kill' stars – most probably awarded for live weapons training.

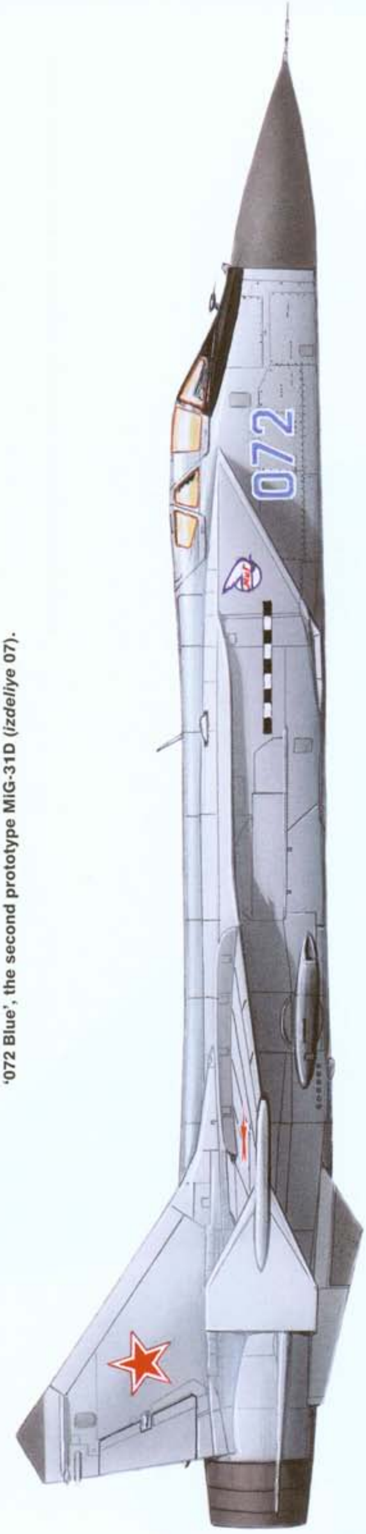


MiG-31 '08 Red' is named *Boris Safonov* in memory of a famous Soviet Navy/North Fleet Air Arm fighter pilot, Twice Hero of the Soviet Union, killed in action during World War Two. The prototype-style blue flash on the intakes is also noteworthy.

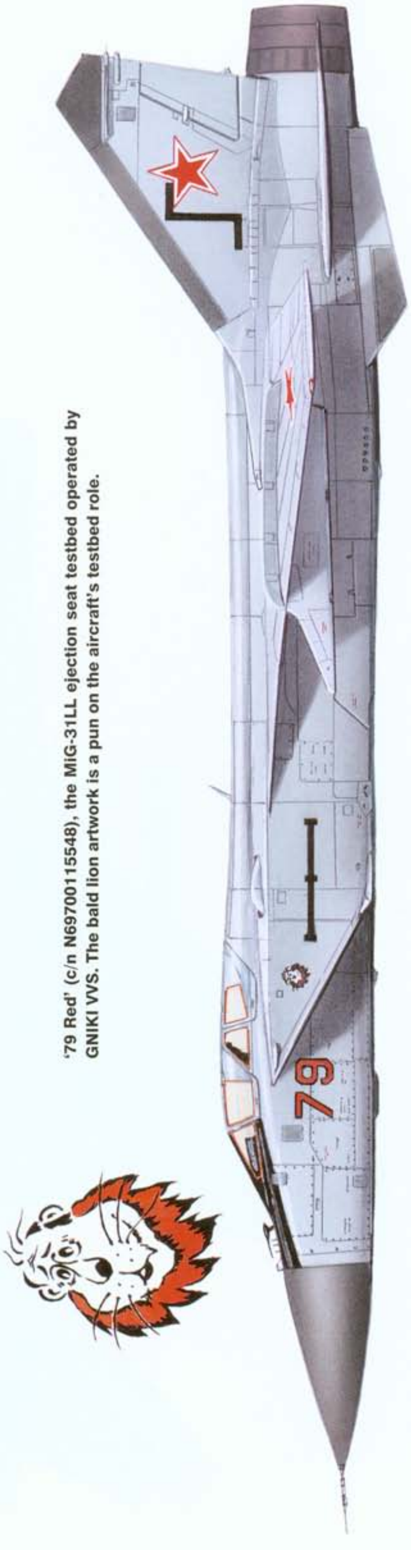


In spite of the Mikoyan OKB badge worn on both air intakes, MiG-31 (*izdeliye* 01DZ) '10 Red' is an operational aircraft, not a company-owned test ship.

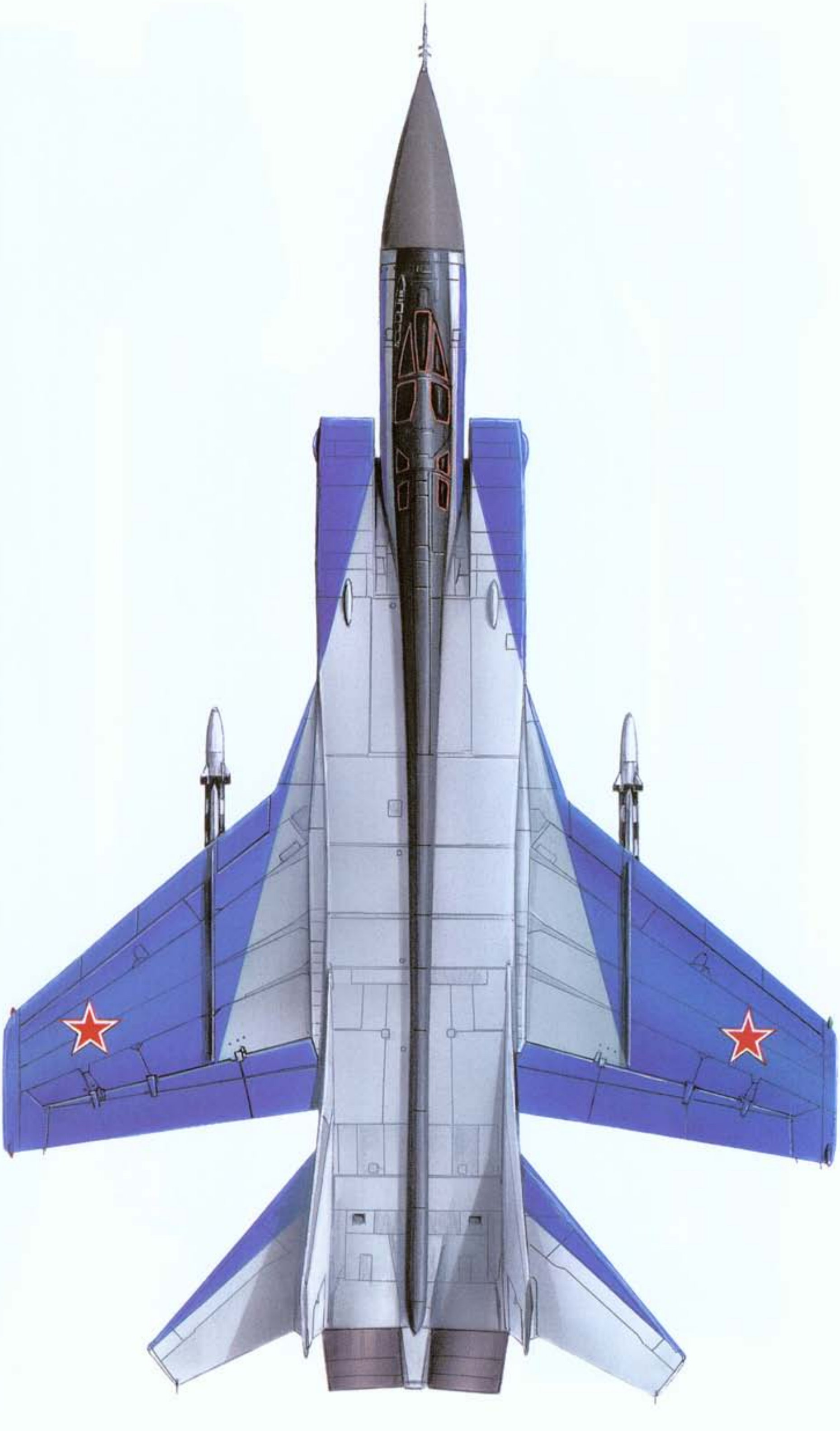




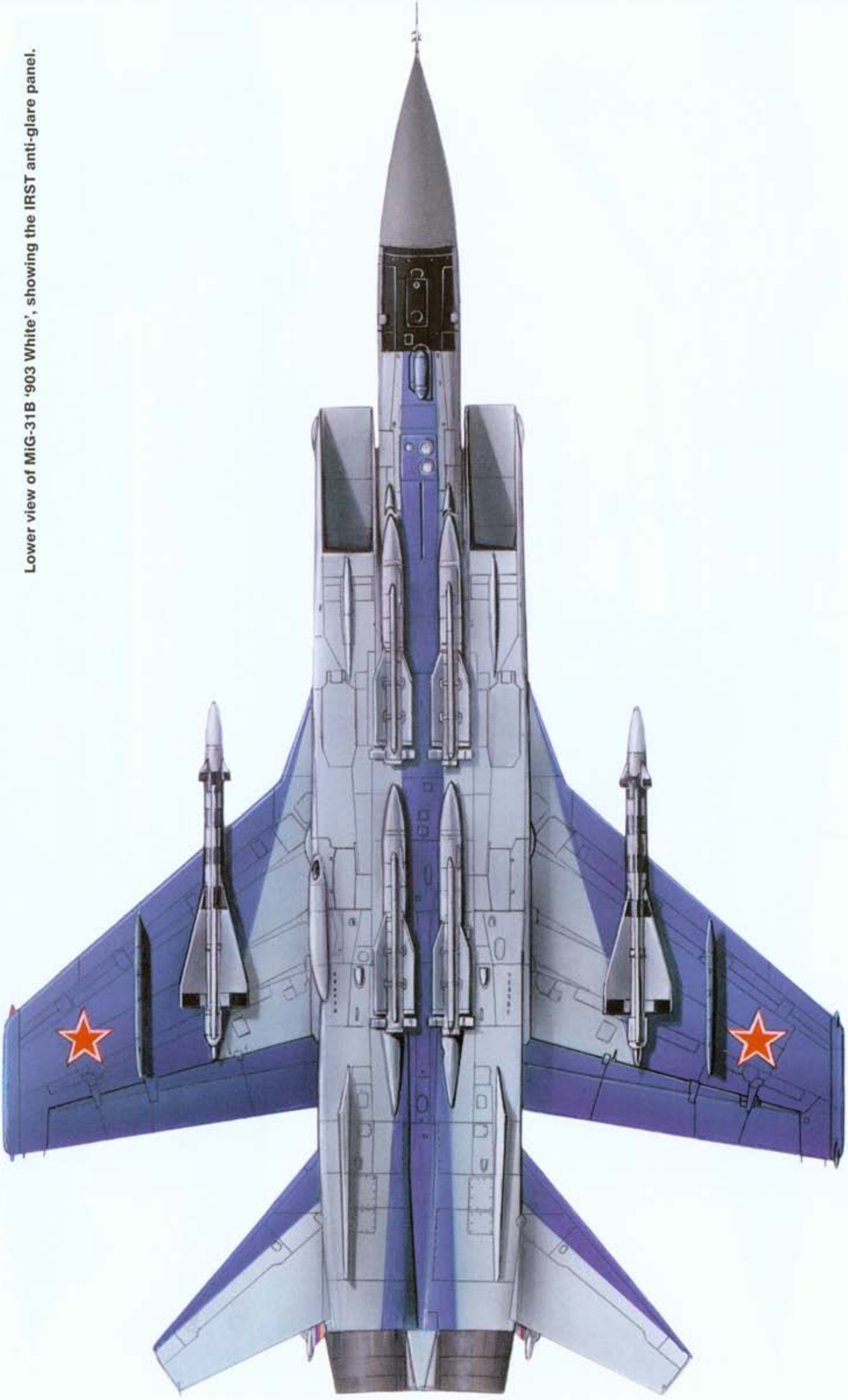
'072 Blue', the second prototype MiG-31D (*izdeliye* 07).



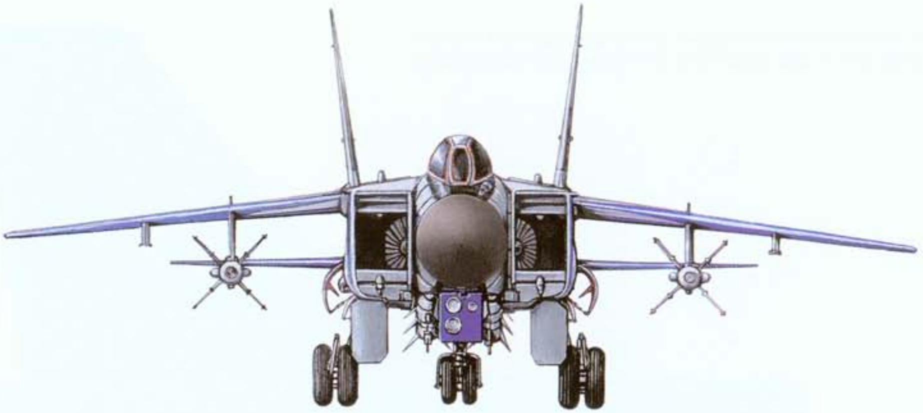
'79 Red' (c/n N69700115548), the MiG-31LL ejection seat testbed operated by GNIKI VVS. The bald lion artwork is a pun on the aircraft's testbed role.



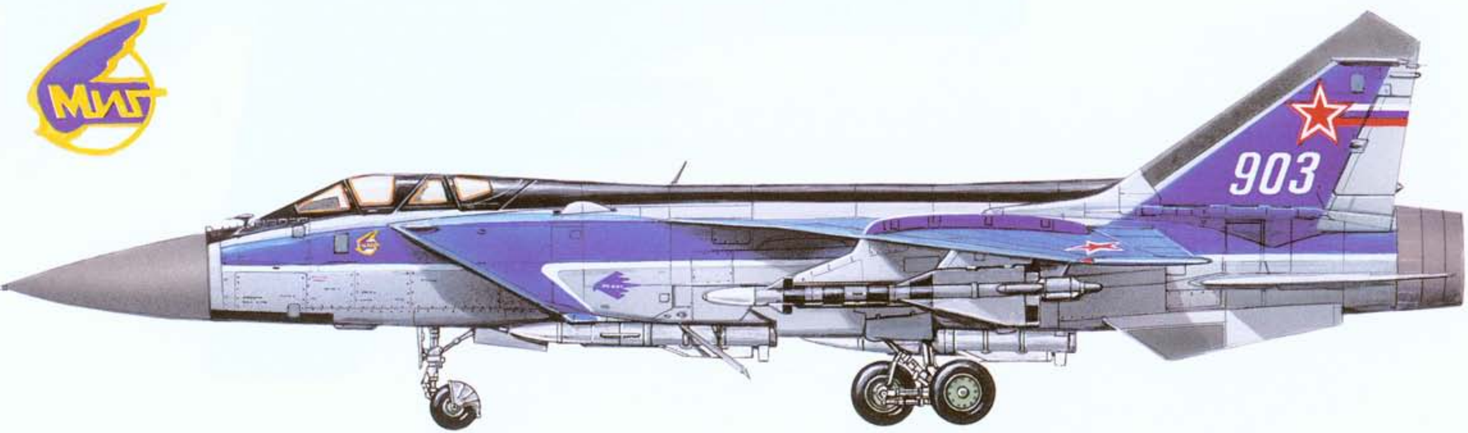
MiG-31B '903 White' is a company-owned demonstrator. The same colour scheme was previously worn by another MiG OKB 'hack', MiG-31 '374 White'.

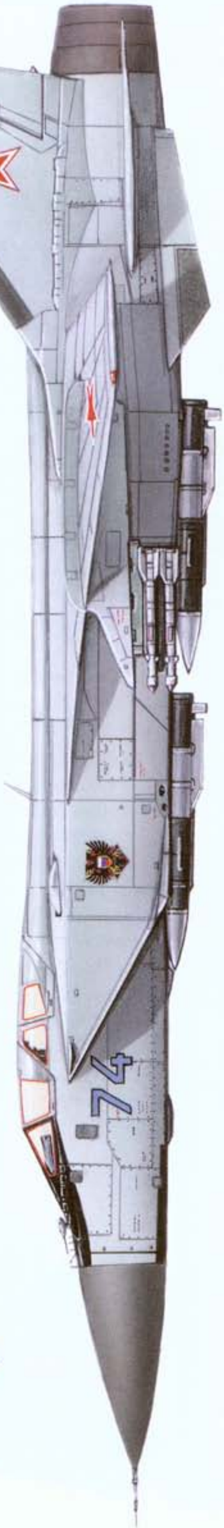


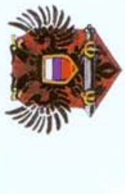
Lower view of MiG-31B '903 White', showing the IRST anti-glare panel.



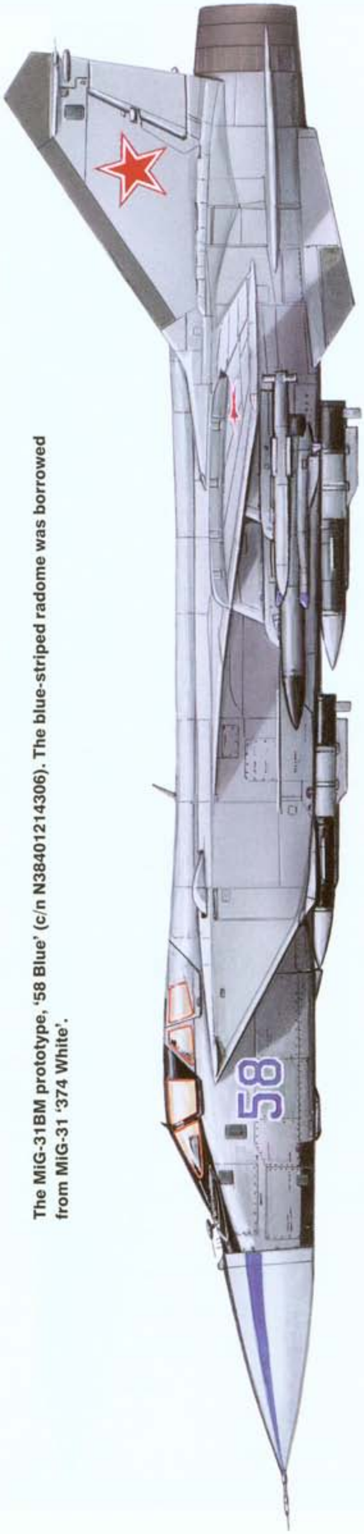
Front and side views of MiG-31B '903 White'. Note the badge of the manufacturer (the 'Sokol' Nizhniy Novgorod Aircraft Factory) on the intake.





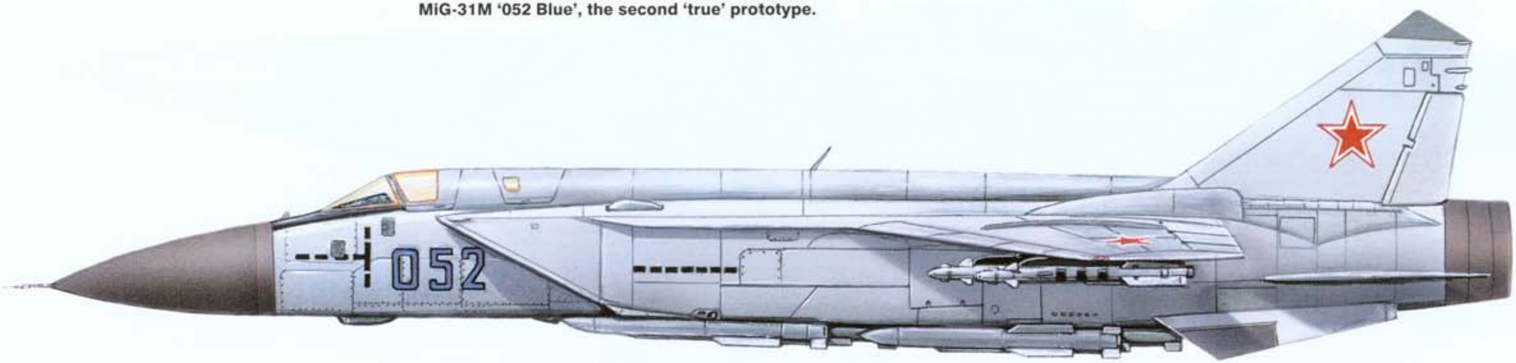


MiG-31B '74 Blue', one of several operated by the training unit at Savasleyka AB. Note the unit badge on the air intake.

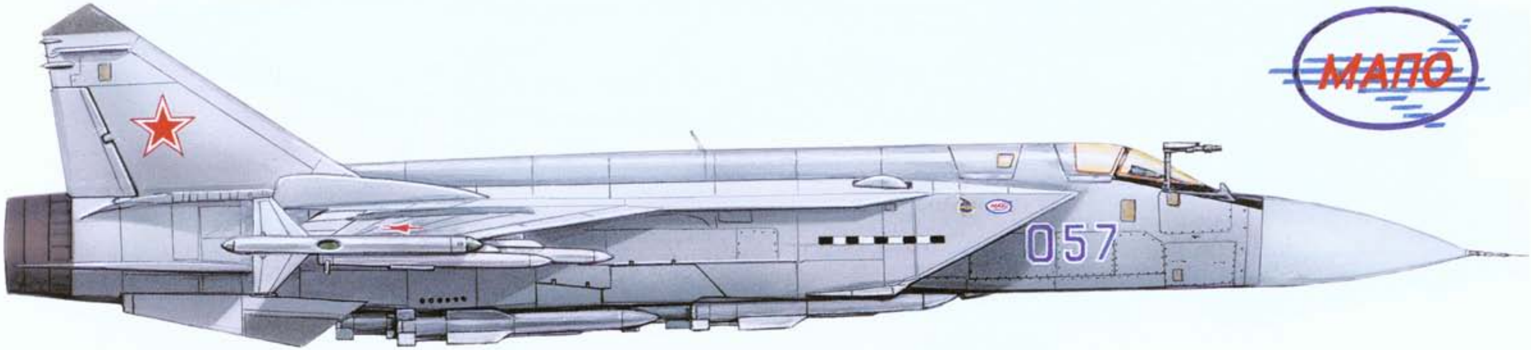


The MiG-31BM prototype, '58 Blue' (c/n N38401214306). The blue-striped radome was borrowed from MiG-31 '374 White'.

MiG-31M '052 Blue', the second 'true' prototype.



MiG-31M '057 Blue' (c/n N72100106176), the final prototype incorporating a number of changes.



Record Achievements

The MiG-31's high performance was obvious from the outset. However, due to the secrecy it was shrouded in, the aircraft was not able to contribute to the noble cause of setting world records until more than 20 years after its official service entry. (In passing, this fact speaks for itself: even now the *Foxhound*'s capabilities are unmatched!)

On 31st July and 1st August 2003 two crews of the Russian Air Force's 929th State Flight Test Centre set no fewer than 22 Class C-1L world records in an early-production MiG-31, flying from their home base at Vladimirovka AB, Akhtoobinsk. (Class C-1L means fixed-wing aircraft with a take-off weight of 35,000-45,000 kg/77,160-99,210 lb.) One crew consisted of pilot Col. Vladimir Goorkin and WSO Col. Aleksandr Kozachemko; the other crew comprised Col. Sergey Seryogin and Col. Aleksey Pestrikov.

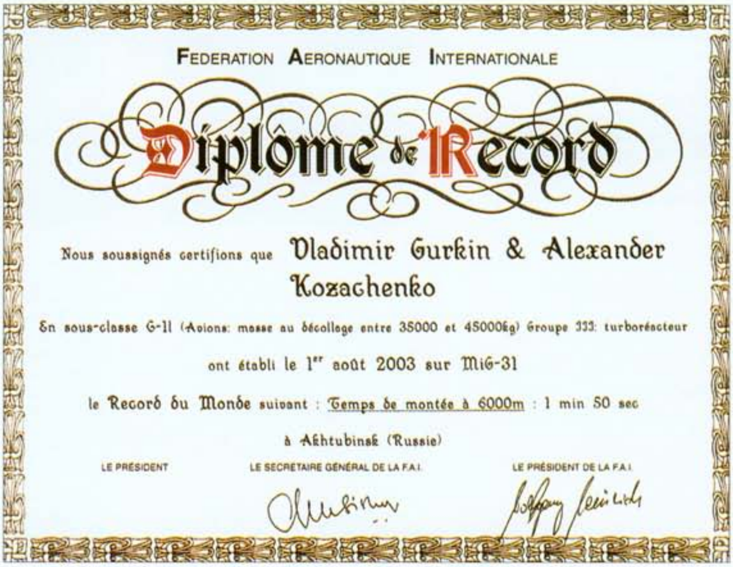
The aircraft had not been modified in any way for the record attempts and carried a representative warload of four R-33 missiles and a full complement of cannon ammunition. The crews did not take any special training for the records either. Also, the weather was not very favourable, with ambient temperatures of more than +30°C (86°F). Nevertheless, some of the records (incidentally, set by the *Foxhound*'s precursor, the MiG-25) were bettered considerably. For instance, the climb time to 12,000 m (39,370 ft) was reduced by a factor of three; the maximum altitude with a payload was improved by more than 5,000 m (16,400 ft), reaching 21,690 m (71,160 ft).

What's more, this is not the MiG-31's limit. 929th GLITs pilots are confident that the aircraft can still set more than 30 world speed, altitude and rate-of-climb records.

Air Fleet Herald

▲
Col. Vladimir Goorkin and Col. Aleksandr Kozachenko after receiving their world record certificates.

The world record diploma issued by the FAI to testify that Vladimir Goorkin and Aleksandr Kozachenko set a Class C-1L world record on 1st August 2003 by climbing to 6,000 m (19,685 ft) in 1 minute 50 seconds.
▼



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Diplôme de Record

Nous soussignés certifions que Vladimir Gurkin & Alexander Kozachenko

En sous-classe C-1l (Avions: masse au décollage entre 35000 et 45000kg) Groupe III: turboréacteur

ont établi le 1er août 2003 sur MiG-31

le Record du Monde suivant : Temps de montée à 6000m : 1 min 50 sec

à Akhtubinsk (Russie)

LE PRÉSIDENT | LE SECRETAIRE GÉNÉRAL DE LA F.A.I. | LE PRÉSIDENT DE LA F.A.I.

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The materials published in the *Nezavisimoye Voyennoye Obozreniye* (Independent Military Review) and *Krasnaya Zvezda* (Red Star) newspapers, the *Kryl'ya Rodiny* (Wings of the Motherland), *Aviatsiya i Kosmonavtika* (Aviation & Spaceflight), *Voyennyy Parad/Military Parade*, Air Fleet, Aviapanorama, *Aviatsiya i Vremya* (Aviation & Time), *Ves'nik Aviatsii i Kosmonavtiki/Aerospace Herald*, *Ves'nik Vozdooshnovo Flota/Air Fleet Herald*, *Tekhnika i Vo'orouzheniye* (Hardware & Armament), *M-Hobby*, *Flight International*, *Aviation Week & Space Technology*, *Air International*, *Air Forces Monthly*, *World Air Power Journal*, *Jane's Defense Weekly*, *Air & Cosmos*, *Flieger Revue* and *Flug Revue* magazines.

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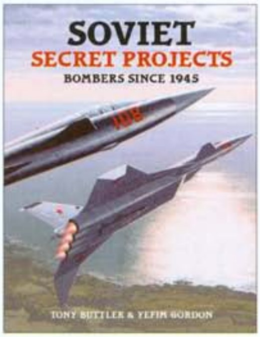

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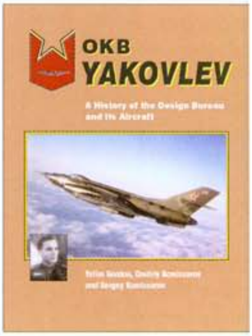

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